U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-260 274

REPORT ON POLLUTION OF LAKE ERIE AND ITS TRIBUTARIES

PART II. OHIO, INDIANA, AND MICHIGAN SOURCES

PUBLIC HEALTH SERVICE, WASHINGTON, D.C.

JULY 1965

001888 254033 PB 260 274

Report on Pollution of Lake Erie and Its Tributaries

Part 2

OHIO, INDIANA, AND MICHIGAN SOURCES

July, 1965

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Public Health Service
Division of Water Supply and Pollution Control

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

BIBLIOGRAPHIC DATA SHEET	1. Report No.	2.	3. Recipient's Accession No. PB-260 274
4. Title and Subtitle Report on Pollution of Lake Erie and Its Tributaries Part II. Ohio, Indiana, and Michigan Sources			5. Report Date Jul 65 6.
7. Author(s)			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Public Health Service, Washington, D. C. Div. of Water Supply and Pollution Control			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address			13. Type of Report & Period Covered 14.

15. Supplementary Notes

See also Part 1, PB-260 273.

16. Abstracts Pollution problems in local areas tributary to Lake Erie within Michigan and Ohio, encompassing also headwater areas in Indiana are discussed. The area is divided into six subareas: (1) Maumee River Basin; (2) Western Ohio; (3) Rocky River Basin; (4) Cuyahoga River Basin and Cleveland Lakefront; (5) Eastern Ohio; and (6) Detroit River and Michigan tributaries. Each subarea is discussed in depth.

17. Key Words and Document Analysis. 17a. Descriptors

17b. Identifiers/Open-Ended Terms

*Water pollution
*Water quality
Maumee River
St. Joseph River
St. Mary's River
Tiffin River
Auglaize River
Rocky River
Cuyahoga River
Grand River
Detroit River
Waste disposal
Fishes
Lake Erie
Michigan
Ohio
Indiana
Cleveland(Ohio)

17c. COSATI Field/Group 13B

18. Availability Statement	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 54
	20. Security Class (This Page UNCLASSIFIED	22. Price

FORM NTIS-35 (REV. 10-73) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 8265-P74

I - INTRODUCTION

This is Part 2 of the report prepared for the conferences to be held at Cleveland, Ohio, and Buffalo, New York, on pollution of Lake Erie and tributaries. Part 1 of the report concerns the main body of Lake Erie, its problems, their causes, and general remedial measures.

This part deals with problems in local areas tributary to Lake Erie within Michigan and Ohio, encompassing also headwater areas in Indiana. The area is divided into 6 subareas, each of which is discussed in one of the succeeding chapters.

II - MAUMEE RIVER BASIN

Description of the Area

The Maumee River system drains portions of Indiana, Michigan, and Ohio. The major portion of the basin is quite flat, particularly the central part.

The soils in the major portion of the basin are predominantly fine textured, poorly drained, and relatively impermeable. The low dry-weather stream flow reflects the highly impermeable characteristics of the soils in the basin. Approximately 92 percent of the total acreage is devoted to agriculture.

The average discharge for the Maumee River at Waterville, Ohio, which records runoff from 96 percent of the basin, was 4636 cfs for a thirty-nine year period prior to 1965. Lowest average flow for a seven-day period having a recurrence interval of once in five years (80%) is 113 cfs.

At the 1960 census, the overall population of the Maumee River Basin was approximately 1,134,000 people. Principal centers of population and industry are Toledo and Lima, Ohio and Ft. Wayne, Indiana. Breakdown by states in the Basin is shown below.

Maumee River Basin Portion by State	Population
Michigan	24,000
Ohio	830,000
Indiana	280,000
Total Maumee Basin	1,134,000

Water Uses

Municipal Use

The total municipal water use by 171 communities in the watershed amounts to 128 mgd, of which 113 mgd are obtained from surface supplies and 15 mgd from underground supplies.

Five municipalities obtain their water supply directly from the Maumee River. These Ohio communities are Waterville, Bowling Green, Grand Rapids, Napoleon, and Defiance. The City of Ft. Wayne, Indiana uses the St. Joseph River as a source of water supply. The communities of Archbold, Wauseon, Findlay, Van Wert, Lima, Delta, Weston, and Swanton, Ohio have impounding reservoirs.

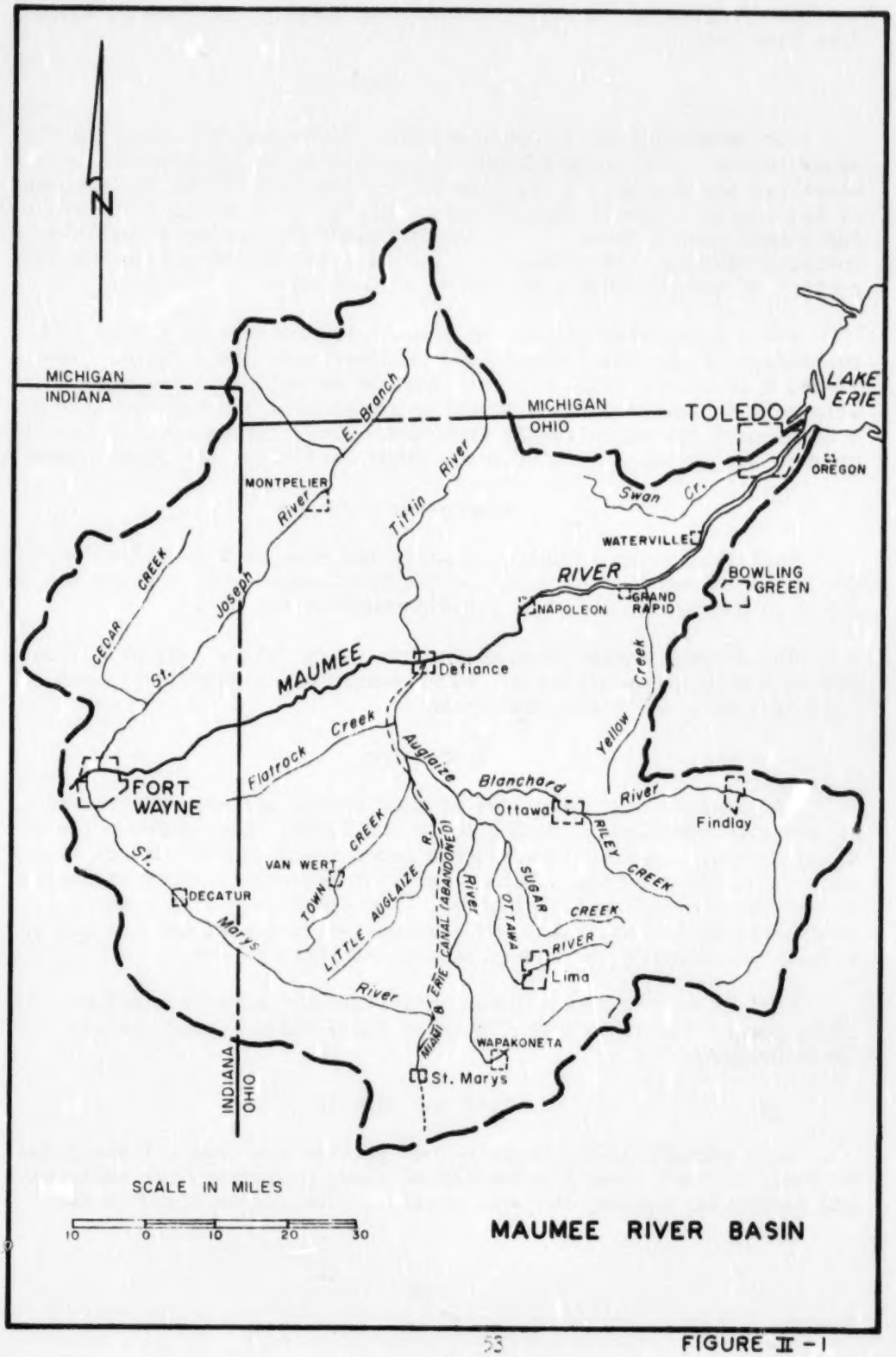
N
MICHIGAN
INDIANA
MICHIGAN
OHIO
TOLEDO
LAKE ERIE
OREGON
E. Branch
MONTPELIER
River
Tiffin River
Swan Cr.
WATERVILLE
RIVER
BOWLING GREEN
NAPOLEON
GRAND RAPID
CEDAR CREEK
St. Joseph
MAUMEE
Defiance
Yellow Creek
Flatrock Creek
Auglaize
Blanchard
River
FORT WAYNE
Ottawa
Findlay
RILEY CREEK
VAN WERT
TOWN CREEK
LITTLE AUGLAIZE R.
St. Marys
DECATUR
River
MIAMI & ERIE CANAL (ABANDONED)
SUGAR CREEK
OTTAWA RIVER
Lima
WAPAKONETA
St. Marys
INDIANA
OHIO
SCALE IN MILES
10 0 10 20 30
MAUMEE RIVER BASIN

FIGURE II - 1

The City of Toledo and its satellites draw an estimated 70 mgd from Lake Erie.

Industrial Water Use

The Campbell Soup Company, Napoleon, Ohio uses the Maumee River for water supply. The company pumps approximately ten million gallons of water per day for use in its soup processing. According to the census of all users, estimated by the Ohio Division of Water in 1955, manufacturing plants used a total of 190 mgd and power plants (municipally-owned, public utilities, and industrial) used a total of 642 mgd in the Ohio portion of the watershed, exclusive of Lake Erie.

Heavy industrial use in the Toledo area amounts to a very high percentage of the total water used in the Maumee River Basin. Ohio Division of Water, 1955, reported that of an estimated 756 mgd of water withdrawn in the area, manufacturing plants used 7.2 mgd, and one power company used 192 mgd directly from Lake Erie. The balance of the withdrawals was by the City of Toledo, other factories, and power plants.

Waterborne Commerce

Port facilities in Toledo provide the area with excellent service for water shipment of products on the Great Lakes and, through the St. Lawrence Seaway, to and from ports throughout the world.

The average annual tonnage for the years 1952 - 1959 at Toledo was 24.6 million short tons. Cargo consisted of petroleum, coal, iron ore, iron and steel, and grain.

Recreation

The recreational resources of this region are meager compared to those found immediately to the south and north. Lake Erie, polluted along much of its shoreline between Detroit and Toledo, offers little inducement for swimming. Inland areas of the region offer virtually no natural recreational facilities. The Grand Lake at St. Marys is classified as a state lake, but this one recreational unit is not in a suitable location for use by many within this region.

Facilities for recreational activities are also provided at Independence Dam State Park, Thurston State Reserve, and Cascade State Reserve.

Fish and Aquatic Life

Most streams of the basin do not provide good sport fishing due to their limited size, fluctuation of flow, pollution from municipal and industrial wastes, and soil erosion. The Maumee River in the

shallows downstream from the old canal feeder dams near Defiance and Grand Rapid was once an outstanding fishing spot for smallmouth bass, rock bass, and channel catfish. According to the Division of Wildlife, Ohio Department of Natural Resources, smallmouth and rock bass, once prevalent, are now totally absent from these waters because of pollution.

Irrigation

According to the 1955 report of the Ohio Division of Water, 1,550 acres are irrigated in the Ohio portion of the Maumee Basin. The total water withdrawal in this area for farm field irrigation in 1955 was 2.1 mgd, distributed equally between surface and ground water supplies.

Irrigation has shown a steady rise since 1950 and the trend toward irrigation is increasing.

Principal Sources of Wastes

The principal sources of pollution in the Maumee River Basin are municipal sewage, combined sewer overflows, and industrial wastes. Other pollution problems have resulted from accidental spills from storage tanks, lagoon breaks, and wastes from ships. Sediment losses from the basin, carried by the stream system into Lake Erie, are heavy. These losses result from a combination of soil characteristics and land use practices.

St. Joseph River

One primary treatment plant, in the Ohio part of this subbasin, treats wastes having an average population equivalent (PE) of 8500 (one PE assumed to equal 1/6 pound per day of BOD). There are six secondary treatment plants, located in Indiana, which treat wastes having a combined total PE of 15,000, before treatment. Twenty-three communities with a total population of 11,000 are not served by community sewerage facilities.

Six major industries operate in the St. Joseph subbasin, of which four are in Indiana and two in Ohio. The Indiana industries are Warner Automotive in Auburn; and Kitchen Quip, Crane-Edmund and Universal Tool in Butler. The two industries in Ohio are Edgerton Metals Products and Bundy Foods in Blakeslee.

St. Marys River

One primary treatment plant located in Ohio treats a total of 440 PE. Five secondary treatment plants have before-treatment PE of 26,410. Three of these are in Indiana and treat 6,890 PE. The remaining

two treat 19,520 PE in Ohio. A total of 12,650 people in eleven communities are unsewered. Five of these communities with 10,050 people are in Indiana, with the remaining 2,600 people in Ohio.

Six major industries discharge to the St. Marys River. Dana Corporation Salisbury Axle Works, Essex Wire, and Central Soya Company are in the Indiana part. St. Marys, Ohio has Weston Paper Company, Goodyear Tire and Rubber Company, and Beatrice Foods Company discharging to the river in that city.

Tiffin River

Five secondary treatment plants have a before-treatment PE of 43,025. One plant is in Michigan having a PE of 2,550, while the remaining 4 are in Ohio. A total of 8,535 people in eighteen communities are unsewered in the Tiffin subbasin. Michigan has 4,095 people in 7 communities with Ohio having the remaining 4,440 in 11 communities.

One principal industry, Defiance Fertilizer Company, is on the Tiffin immediately above Defiance, Ohio.

Auglaize River

The Auglaize River subbasin which includes the Ottawa and Blanchard Rivers has seventeen secondary sewage treatment plants receiving a PE of 167,155. In fifteen communities 23,840 people are unsewered in this subbasin.

Thirteen major industries discharge to the waters of the Auglaize, Blanchard and Ottawa Rivers. Namco, an aluminum anodizing plant and Ohio Decorative Products, a plating operating, discharge directly to the Auglaize River. Five major industries use the Blanchard River for waste disposal. Three are in Findlay and include Contris Packing Plant, Davison Chemical Company and National Oil Refinery. The remaining two are Rusco, Inc., an aluminum plating company in Pandora, and Buckeye Sugar Inc., in Ottawa. The sugar mill discharges an average of 2,160 pounds BOD per day during seasonal operation, September-December. The remaining six industries in the Auglaize subbasin discharge into the Ottawa River and are located in Lima.

Heavy chemical pollution is present in the Ottawa from Ford Motor Company, Standard Oil Refinery, Republic Creosote, Sohio Petrochemical Company's acrylonitrile and acetonitrile plant, Sohio Chemical Company's petrochemical plant, and Excello Company, a ferrous fabricated metal products plant. Phenolic and nitrogen compounds are discharged, causing problems in the Ottawa.

Upper Maumee River, Ft. Wayne, Indiana to Napoleon, Ohio

One primary treatment plant treats 9,650 PE in the Ohio portion.

Five secondary treatment plants receive a total PE of 213,540, four of them being in Indiana and totalling 211,940 PE. The largest is Fort Wayne, Indiana with a 207,000 population equivalent. A total of 3,470 people in six communities are unsewered. Ohio has 2,485 in four communities, and Indiana has the remaining 985.

Industries number twelve in the Upper Maumee. Central Foundry and Lectrolite Company are located in Defiance and discharge directly to the Maumee. Discharging through the Defiance Sewage Treatment Plant is Johns Manville Company having large quantities of phenolic materials as wastes. The fourth industry, Weatherhead Corporation, is at Antwerp, Ohio. Cyanide and oil discharges create a local problem. The remaining eight industries are in Indiana. B. F. Goodrich Rubber Plant is located near the Maumee at about mile point 119.0. This plant has sewage treatment facilities and discharges a small amount of BOD. Harvester Ditch below Ft. Wayne carries the wastes of four industries. These are Gladieux Oil Company, Phelps Dodge, Magnavox, and International Harvester. The BOD loading from this stream averages about 60 pounds per day. The remaining industries are Parrot Packing Company and two plating companies, General Plating and Franke Plating. The packing plant increases the BOD loading in the river below Ft. Wayne by 890 pounds per day. Oils are also contributed in the amount of 136 pounds per day. Two plating companies in Ft. Wayne contribute large amounts of cyanides and heavy metals. One company discharges on the average 38 pounds of cyanide per day.

Lower Maumee

Two primary treatment plants receive for treatment a PE of 3,660. Nine secondary treatment plants treat a total of 609,400 PE, of which a PE of 575,000 comes to the Toledo sewage treatment plant. Even though secondary treatment is employed, this plant discharges on the average approximately 18,000 pounds of BOD every day into the river and Maumee Bay at the western tip of Lake Erie - an indicated reduction of 81 percent by treatment. A total of 10,850 people in twenty-three communities are not served by central collection and treatment systems.

Seven industries discharge to the Maumee in the Toledo area. Three of these are oil refineries which include Standard, Gulf, and Sun. The remaining four are Interlake Iron Company, Toledo Edison, Libbey-Owens-Ford, and Allied Chemical Company. Oil scum, metallic deposits, and toxic materials are contributed by these industries.

Effects of Wastes on Water Quality and Water Uses

St. Joseph River

The overall water quality of the St. Joseph River above Montpelier,

Ohio, is good. Below Montpelier the concentration of dissolved oxygen falls to an average of 4 mg/l during low flow. A minimum concentration of 2 mg/l was recorded several times during late summer. The treatment plant effluent has a DO (dissolved oxygen) of 4.5 mg/l and a BOD of 796 pounds per day. The flow of the stream during the sampling period at this point was 17 cfs or less 18 percent of the year. Biological conditions typical of gross pollution existed during these low flows. The stream bottom is silt, mud, and detritus. An oily sludge was observed during low flow conditions. Bottom dwelling animals were limited to the pollution-tolerant sludgeworms and midge larvae.

St. Marys River

A dissolved oxygen sag occurs on the St. Marys River below the City of St. Marys. The combination of industrial wastes and the St. Marys sewage treatment plant effluent lowered the DO to below 4 mg/l about 85 percent of the sampling period June 1964-March 1965. The DO at this point was below 1 mg/l 50% of the time. Four and one-half miles above this sampling point three major industries and a secondary sewage treatment plant, as tabulated below, discharge their wastes directly to the River:

Waste Source	5 day BOD Discharged
Weston Paper Manufacturing Company	320 lbs./day
Goodyear Tire and Rubber Company	344 lbs./day
Beatrice Foods Company	11 lbs./day
St. Marys Sewage Treatment Plant	290 lbs./day
Total industrial and municipal wasteload	965 lbs./day

During the period October-December, 1964, the median coliform densities in this area were 540,000 per 100 ml with a range of 10,000-2,900,000. The maximum fecal streptococci densities recorded were 155,000 per 100 ml.

At certain times of the year, in addition to known waste inputs, large quantities of deoxygenating wastes are discharged to the river in the St. Marys area. The most recent occurrence was about May 15, 1965. The waters below St. Marys were black and septic. The dissolved oxygen was zero for 20 miles downstream.

Biological sampling in the early spring of 1964 disclosed a sparse population of pollution-tolerant midge larvae and sludgeworms. The stream bottom was sand, rubble, and rock, and no sludge deposits were found. By July, a black septic sludge had accumulated over the stream bottom and emitted a strong septic odor. Because of severe environmental conditions, no bottom dwelling organisms were found during the summer or fall surveys.

Another dissolved oxygen sag occurs downstream from Decatur, Indiana. Four miles below Decatur, the DO was below 4.0 mg/l for 20 percent of the time during the period June 1964-March 1965. The DO range was 1.4-11.8 mg/l. The maximum 5-day BOD concentration was 17.6 mg/l. The secondary waste disposal plant at Decatur discharges an estimated 240 pounds of BOD daily. The principal industry, Central Soya, releases only 4.3 lbs/day BOD from its oxidation ponds. Stream flows in this area during August-September, 1964 had monthly averages of less than 16 cfs. Although the BOD loading from the Decatur Sewage treatment Plant is relatively low, the stream cannot accommodate these loads because of low flow during the summer and fall.

Auglaize River Basin

Since the majority of wastes discharged to the Auglaize River are received from its tributaries, sampling stations were positioned to determine the effect of streams discharging to the main stem.

The major source of municipal and industrial pollution discharges directly to the headwaters of the Auglaize at Wapakoneta, Ohio. During the period July-November 1964, the sewage disposal plant at Wapakoneta discharged a variable BOD loading to the Auglaize ranging from 178 lbs./day to 1700 lbs./day. Flow in the stream below this discharge was below 6.4 cfs during 90 per cent of the sampling period. The River receives industrial waste discharges at Wapakoneta from two packing companies, a Pepsi-Cola bottling plant, and the Monarch Battery Company. No records on the effluents from these industries have been made available. The dissolved oxygen below Wapakoneta falls to zero during low flow periods. Dissolved oxygen was below 4 mg/l downstream approximately 31 per cent of the time. During the period October - December, 1964, the median coliform density was 140,000 organisms per 100 ml, with a range of 1,200 to 11,000,000.

The Auglaize River above Wapakoneta supports a well-balanced biological population at all seasons of the year. Pollution-sensitive species of mayflies, caddis flies, and scuds were common. Below the town, the water quality is severely degraded. Although bottom fauna of pollution-sensitive mayflies, caddis flies, and dragon flies were found to be fairly numerous in the spring of 1964, by July all pollution-sensitive organisms had been eliminated and only sludgeworms and midge larvae remained. The stream bottom which had been scoured clean of silt and organic deposits during the spring was covered with black, septic, malodorous sludge by July. Below this point, the Auglaize River quickly recovers and for over 50 miles, dissolved oxygen, biochemical oxygen demand, microbiological and biological data gave little evidence of organic pollution.

The Ottawa River is grossly polluted--the worst in the entire Maumee River Basin. The stream degenerates rapidly at Lima, Ohio, and never recovers. Thirty-three miles below Lima, the water was still highly colored, ranging at times from red-orange to black. Oil was also much in evidence along banks throughout the reach.

Above Lima, the median dissolved oxygen was approximately 5 mg/l. At station 31.8 below Lima, the dissolved oxygen was consistently below 1 mg/l. Thirty miles below Lima, at the stream's junction with the Auglaize, the median dissolved oxygen was still below 2 mg/l with many values near zero.

Biochemical oxygen demand values immediately below Lima ranged from a low of about 20 mg/l to approximately 215 mg/l. Near the mouth of the river, these BOD varied from 10 to 85 mg/l. Median coliform concentration in the Ottawa River ranged from 6,200 to 2,300,000 organisms

per 100 ml for the entire sampling period. The median value for fecal coliform was 42,000 organisms per 100 ml, and for fecal streptococci 10,000 organisms per 100 ml. A severe bacterial pollution exists at all points sampled.

The high coliform densities, accompanied by high fecal coliform and fecal streptococci densities, confirm the presence of gross polution from human wastes.

This heavy chemical pollution adversely affects water supplies on the Maumee. Phenolic concentrations directly below Lima ranged from 40 ug/l to 19,000 ug/l and at the mouth from 13 ug/l to 1,400 ug/l. Chemical oxygen demand (COD) values ranged from 30 mg/l to 540 mg/l below Lima and from 35 mg/l to 515 mg/l at the mouth. Concentrations of ammonia ranged from 22 mg/l to 127 mg/l below Lima with a median value of 63 mg/l. One mile above the mouth of the Ottawa River, ammonia concentrations ranging from 12 mg/l to 136 mg/l were detected. The median value for the period July 1964 - February 1965 was 60 mg/l.

Below Lima, rooted aquatic plants, attached algae, and bottom dwelling animals were completely absent in all seasons. The stream bottom is rock and shale which in the spring was scoured clean of any silt or sludge. During low flow in the summer, a black, oily sludge with a strong petrochemical odor accumulated over the stream's bottom. Between Lima and the confluence with the Auglaize River, the Ottawa showed no signs of biological recovery. The only aquatic life observed in this reach was a very sparse population of sludgeworms and midge larvae near the mouth. The rocks and shale were completely devoid of attached algae and aquatic weeds. The complete absence of attached algae and bottom dwelling animals indicates not only severe oxygen deficits but the presence of highly toxic chemicals.

Wastes discharged to the Ottawa River from the Sohio industrial complex at Lima include oil, phenolic compounds, ammonium nitrate, anhydrous ammonia, urea, aceto - and acrylo-nitriles and cyanides. It has not been possible to obtain details of industrial waste effluents from this complex. Other significant wastes are 24 lbs./day of oil from Excello Corporation, 19 lbs./day oil and 7.7 lbs./day of phenol from Republic Creosote. Ford Motor Company discharges its wastes to Sugar Creek, consisting of 67 lbs./day of oil and 51.3 lbs./day of BOD.

Samples collected from the Blanchard River reveal two critical areas. The first dissolved oxygen sag occurs in the Blanchard River immediately below the City of Findlay, about mile point 52.5. Dissolved oxygen values below 4 mg/l occurred about 38 percent of the time.

Immediately below the Findlay sewage treatment plant, the water quality was severely degraded as indicated by the presence of only the pollution-tolerant sludgeworms, midge larvae, and air breathing snails. The stream bottom was silt and gravel with sludge banks along the edge.

Sewage solids were observed floating in the water. The major oxygen consuming loads to the Blanchard originated from the following sources:

Waste Source	5 day BOD Discharged
Findlay Sewage treatment plant (Average value for October and November 1964)	953 lbs./day
Contris Packing	7 lbs./day
National Refinery	35 lbs./day
Total 5-day BOD	995 lbs./day

The wastes associated with these loads had a flow of 5 mgd and a dissolved oxygen concentration of 1.7 mg/l. The river flow below the Findlay Sewage treatment plant was almost entirely the effluent from the sewage treatment plant for three months, August, September, and October, 1964. The River recovers rapidly, and two miles below the sewage treatment plant the biota are typical of those found in a recovery zone.

Another oxygen sag occurs below Ottawa, Ohio. In addition to the municipal effluent from the city, the Buckeye Sugar Inc., which begins normal seasonal operation in October, discharged 2.59 mgd of waste with a BOD of 2,160 pounds per day. The high oxygen demand of these wastes caused the dissolved oxygen in the Blanchard River to fall to zero for a stretch of some 20 miles downstream to the point of confluence with the Auglaize River.

On the Blanchard River below Ottawa the median dissolved oxygen was 4.8 mg/l during June-September, zero in October and November. These conditions were the same at every sampling station to the confluence with the Auglaize River.

Below Ottawa, the median coliform densities increased from 290,000 organisms per 100 ml during the June-September period to 3,400,000 during the October-December period. The highest value recorded during this period was 114,000,000 coliform organisms per 100 ml.

Biological surveys confirmed these findings of gross pollution. In October, conditions typical of a grossly polluted stream were observed. A strong odor of hydrogen sulfide permeated the area. The water was black, and the rocks in the stream were covered with black scum. Only the most tolerant forms of biological life were found throughout the length of the river to its mouth.

Below the confluences with the Ottawa and Blanchard Rivers, another dissolved oxygen sag occurred. This is the most critical area of poor water quality on the river. During the summer, dissolved oxygen concentrations averaged 2 to 3 mg/l; during low flow in the fall season, it frequently dropped to below 1 mg/l. At mile point 25.6, which is

directly below the confluence of the Blanchard River, the biochemical oxygen demand ranged from 4 to 40 mg/l while phenol concentrations averaged about 28 ug/l (micrograms per liter). The maximum value of phenol was about 140 ug/l.

During the summer, extensive algal growths were observed on the Auglaize River. Stream sampling indicated that, during the warm months, such compounds as phenols and organics were rapidly assimilated. During the winter months, the colder stream temperatures allow greater concentrations of these organic compounds to reach the Maumee River. Ammonia concentrations which averaged less than 2 mg/l during July and August 1964 in this area rose to a median concentration of 42 mg/l, and as high as 84 mg/l during October to December. These results reveal that the Auglaize is severely affected by the Ottawa and Blanchard Rivers during periods of low flow and low stream temperatures.

Five miles downstream the Auglaize deepens and the velocity decreases due to the pool formed by an old power dam at mile point 5.4. At mile point 14.8 bottom animals were limited to sludgeworms and midge larvae. Only the most tolerant bottom dwellers survive. In the lake behind the dam, phytoplankton productivity is high and oxygen supersaturation often occurs at the surface.

Immediately below the power dam, widely diversified fauna with many pollution-sensitive species were found, indicating that the water below the dam was well oxygenated. The abundance of Cladophora and the high plankton counts observed in the summer and fall are manifestations of the high nutrient content of the Auglaize River.

About two miles below the old power dam, the backwaters of the Maumee River above Independence Dam begin to exert an effect on the Auglaize. Between mile point 3.5 and the confluence with the Maumee River the bottom animals are limited to sludgeworms and midge larvae. Photosynthetic oxygen production by the large algal population occasionally gave surface DO values of 20 mg/l.

Substantial winter fish mortalities of shad and other rough fish have been observed in the lower reaches of the Auglaize during the past four years. Since low dissolved oxygen was not a problem at that time of year the kills most likely resulted from the large ammonia concentrations mentioned previously.

The Little Auglaize River, Flatrock Creek, and Sugar Creek exert little, if any, effect on the main stem of the Auglaize.

Town Creek is a tributary to the Little Auglaize River and drains an area of 51.4 square miles. Samples from this stream, collected at a point below Van Wert, Ohio, revealed gross pollution during low flow. The dissolved oxygen dropped to zero in the summer. Samples collected were septic and foul smelling. Coliform densities exceeding 50,000,000 organisms per 100 ml were found.

Tiffin River

The overall water quality is good throughout the entire length of the Tiffin River. The dissolved oxygen exceeded 4 mg/l. The highest coliform densities were recorded near Stryker and Defiance, Ohio. These counts, however, rarely exceeded 5,000/100 ml. The highest fecal streptococcus values were obtained above Defiance and averaged 2,000/100ml.

Upper Maumee River - Ft. Wayne, Indiana to Napoleon, Ohio

Directly below Ft. Wayne, Indiana, an oxygen sag occurs with values below 4 mg/l about 64 percent of the time. BOD values were in the range of 4-15 mg/l. For the period October - December, 1964, phenol concentrations at this point had a median value of 5.2 ug/l. During the winter period January to March, 1965, these concentrations ranged from 3 ug/l to 137 ug/l with a median value of 35 ug/l. The median total coliform count was 910,000 per 100 ml with a maximum of 24,000,000 per 100 ml during June to September, 1964. The median fecal streptococcus value was 1,300 per 100 ml during the same season.

In the Fort Wayne area, biological conditions are seriously degraded. The stream bottom has heavy deposits of oily organic sludge and supports only a sparse population of pollution tolerant sludgeworms and midge larvae.

The significant waste loads in the area originate from the following sources:

Ft. Wayne Sewage Treatment Plant	2200 lbs./day 5-day BOD
Parrot Packing House	890
Harvester Ditch	60
	3150 lbs./day 5-day BOD

Other significant wastes from these industries include:

Parrot Packing	136 lbs./day oil
Franke Plating	38 lbs./day cyanide

Between Fort Wayne and Antwerp, Ohio, the nutrient-rich waters develop tremendous phytoplankton population with counts in excess of 30,000 per ml. In this area algal photosynthesis is the most important factor affecting DO between April and December. Diurnal DO studies at Antwerp showed ranges of 3.8 to 8.2 mg/l and 10.3 to 20.0 mg/l on two 24-hour studies in July. The presence of relatively intolerant bottom dwelling animals in the Antwerp area indicates that prolonged periods of low DO do not occur here.

Thirty-six miles downstream near Antwerp, Ohio, Weatherhead Corporation discharges 33 lbs./day BOD and 240 lbs./day of oil.

At Defiance, Ohio, another oxygen sag occurs. This point is above the sewage treatment plant and is attributed to a large number of the unsewered and/or faulty sewered residences in Defiance discharging raw sewage into the Maumee River. The sewage collection system is faulty in that the sewage treatment plant is closed 30 to 60 days each year. As the River stage rises 5 feet above normal, water is backed up in the main lift station closing the main interceptor and sewage is bypassed directly to the River 2 miles above the Plant. This is the area in which the oxygen sag occurs.

The DO was below 5 mg/l 20 per cent of the time during the period June to September, 1964, with a range of zero to 10 mg/l. During October to November, dissolved oxygen concentrations fell below 5 mg/l 11 per cent of the time with a range of 4.9 to 13 mg/l. Median coliform counts in this area were 54,000 per 100 ml with a maximum value of 830,000 per 100 ml. The highest fecal strep values in the upper Maumee River were obtained in this area during the summer of 1964. A median value of 10,000 per 100 ml and a maximum value of 530,000 per 100 ml were found.

Phytoplankton counts were in excess of 100,000 per ml during the summer of 1964. During the same period, diurnal DO studies showed considerable vertical and diurnal variations. Values as high as 10 mg/l were often found at the surface while the bottom waters contained only 0.5 mg/l. Diurnal variations gave early morning concentrations of 8.0 mg/l at the surface and 25 mg/l in the afternoon. These low DO values at the bottom confirmed the absences of any intolerant animals on the stream bottom.

The sewage treatment plant at Defiance provides only primary treatment facilities. An industrial and municipal waste survey by the State of Ohio indicated 1770 lbs./day BOD and 6750 lbs./day total solids in the final effluent. Phenol concentrations in the range of 14,000 - 22,000 ug/l were recorded, which averaged slightly less than 100 lbs. of phenol discharged per day. Most of the industry in Defiance is sewered. However, primary treatment cannot assimilate the heavy loading of phenolic compounds from the Johns-Manville Fiberglass Company.

A few hundred yards below the Defiance sewage treatment plant, wastes from the Central Foundry Division of General Motors Corporation are discharged. Visual inspection revealed large deposits of cinder and ash material in the River.

Below Independence Dam, the wide variety of intolerant bottom dwelling animals indicated that prolonged low DO conditions do not exist. The waters are rich in phytoplankton, and DO values well in excess of saturation occur during the day.

At Napoleon, Ohio, wastes discharged to the Maumee River originate from two major sources. The sewage treatment plant discharges an estimated 184 lbs. of BOD, and The Campbell Soup Company 4,620 pounds of BOD, and 268 pounds of oil daily.

The river at Napoleon is 6 to 10 feet deep because of backwater of Providence Dam about 9 miles downstream. During summer months, dissolved oxygen drops to zero at times.

Cities situated on or near the Maumee River draw their raw water supply from the highly polluted waters of this stream. Taste and odor control is among the immediate and major problems in this area.

Taste and odor problems are prevalent throughout most of the year in the water supplies at Defiance and Napoleon. At Defiance, during periods of low temperatures and ice cover, problems are encountered with phenolic compounds. The finished water imparts a medicinal taste and odor enhanced by chlorination. During the period of Spring runoff, the water has an intense earthy or musty taste. During late Spring in 1963, '64, and '65, there were periods of exceptionally severe taste and odor problems. The water during these periods was described variously as musty, moldy, earthy, fishy, and "rotten".

The taste and odor problems at Napoleon are similar to those in Defiance with the exception of additional interference from ammonia compounds from the Auglaize River. Campbell Soup Company has reported taste and odor problems of such severity that the plant had to shut down at times because of its inability to produce a taste and odor free water. Large concentrations of ammonia at the plant have created peak chlorine demands as high as 150 mg/l. The company reports that that quality of its raw water supply has steadily deteriorated since 1957.

Lower Maumee and Bay Area - Napoleon, Ohio - Toledo, Ohio

The waters in the lower Maumee River are severely polluted. Very high coliform densities were recorded in the lower River reaches, with median densities in excess of 150,000 organisms per 100 ml at mile point 0.3, and the highest values were greater than 1,500,000 organisms per 100 ml. The ratio of fecal coliform to fecal streptococcus was consistently above two, and as high as 150, indicating that the fecal bacteria are from human sources. The existence of human enteric pathogenic microorganisms was also revealed. Salmonella was detected 40 per cent of the times sampled, confirming the health hazard to persons exposed to these waters.

The dissolved oxygen was observed to be below 4 mg/l at several locations in this portion of the stream.

Phenols are discharged into the Maumee River by Interlake Iron and Johns Manville Companies located near Waterville. Phenols from Interlake Iron reach concentrations of 1,000 ug/l.

Municipal wastes are discharged to the Maumee by the communities of Perrysburg and Waterville. The sewage treatment plant at Perrysburg has primary treatment and discharges on the average 320 pounds of BOD per day. Waterville has a secondary plant that discharges about 32 pounds of BOD per day.

Effluent from the Toledo Sewage Treatment Plant is discharged to the river at mile point 0.6. This plant has secondary treatment and removes 85-90 percent of biochemical oxygen demand (BOD). Even so, the plant discharges on the average approximately 18,000 pounds of BOD every day into the river and Maumee Bay.

In addition to the effluent from the Toledo treatment plant, industrial wastes are being discharged throughout this lower reach. They include oil, scum, metallic deposits, and toxic materials. Oils are being discharged to the Maumee by refineries. Standard, Gulf, and Sun Oil Companies are responsible. Interlake Iron and Libbey-Owens-Ford also contribute large amounts of oil each day.

With all these wastes being contributed to the Maumee River and Maumee Bay recreational use of these waters is severely damaged in the Toledo area, and swimming, water skiing, boating, and other water contact sports are hazardous to health. Grand Rapid, Waterville, and Bowling Green obtain raw water from the Maumee River near Waterville, Ohio. The odors in the raw water at the Bowling Green Water Treatment Plant range through aromatic, earthy, septic, flowery, vegetative, grassy, fishy, and phenolic. Summer problems are with algae growth and decay, and resulting taste and odor. In recent winter periods, the ammonia content of the river water has reached 20 mg/l. Nitrates have reached values of 68 mg/l, and phosphates 2 mg/l. Synthetic detergents have also been a problem, causing foam four feet high on the recarbonation basin. Odors during the winter have been described as stale, rancid, and ammoniacal.

During low flow periods in the summer and early fall, problems originate from the great abundance of algal growths. These growths thrive on abnormally high concentrations of phosphate and nitrogen nutrients available in the water. During the late fall and winter seasons, phenolic and ammonia compounds from Ft. Wayne, Defiance, and Lima are able to survive oxidation for longer periods of time. Subsequently, these compounds reach raw water supplies all along the Maumee River.

Sediment is a problem in the navigation channel, which extends approximately seven miles upstream from the mouth of the river and must be continuously dredged. The suspended sediment is of the clayey type and stays in suspension for long periods of time.

The U. S. Geological Survey data for the water year of 1963 indicated that over 285,000 tons of sediment were carried by the Maumee River at Waterville.

Effects on Lake Erie

Maumee River water severely affects Maumee Bay, which is the western tip of Lake Erie, in that it limits or affects the water uses of recreation, water supply, and esthetics.

Swimming, water skiing, boating and other water contact sports are affected by the health hazards due to the presence of human enteric pathogens such as Salmonella in the Maumee River.

Only one major Lake Erie swimming beach, Reno Beach, exists in the Toledo area. Reno Beach is officially closed because of bacterial contamination from the Maumee River.

The City of Toledo obtains its water supply from an intake located in Lake Erie approximately 9 miles east of the Maumee River. Toledo water is occasionally affected by Maumee River water. Its problems are not on the same scale as those cities whose source is exclusively the Maumee River. It is estimated by the City of Toledo that during some Spring runoffs, the Toledo intake will receive 70 to 90 per cent water from the Maumee. When this happens, hardness and alkalinity levels increase and occasional blooms of algae increase the taste and odor in its water. These blooms are fed by the large amount of nutrients being contributed to the Bay by the Maumee and also from the Toledo Sewage Treatment Plant.

Because Lake level fluctuations have been found to affect the Maumee River as far as 15 miles upstream, any form of pollution which enters the Maumee at its lower points also affects upstream portions of that section of river.

The City of Oregon obtains its water supply through an intake located east of Toledo's in Lake Erie.

Recommended Actions

The recommendations for pollution abatement set forth in Chapter I, Part 1 are to be adopted where applicable in the Maumee River Basin. In addition, it is recommended that the following specific actions be taken:

1. The City of Defiance improve its collection system and treatment facilities, and resolve with Johns Manville Company the problem of excessive phenol discharges.

2. The following industrial plants take the necessary action to provide waste treatment facilities to reduce their waste loadings to the receiving stream:

Interlake Iron Company	Solids reduction
Johns-Manville Company Waterville	Solids and BOD reduction

Defiance	Phenol reduction
Buckeye Sugars, Inc.	Evaluate completed improvements
National Refinery	Oil removal
Standard Oil Company	
Refinery	Phenol reduction
Petrochemical	Evaluate completed improvements
Chemical Company	Nitrogen removal

3. Intensified effort in control of soil erosion and land use practices, to reduce the inputs to receiving waters of silt and nutrients.

4. The Department of Health, Education, and Welfare, in cooperation with other Federal agencies and the States involved, investigate means of providing streamflow regulation to maintain desirable water quality after all practicable measures have been taken to eliminate or control waste discharges at their sources.

5. The unknown source of waste on the St. Marys River be located and brought under control.

III - WESTERN OHIO

Description of Area

The Ohio tributaries to Western Lake Erie are the Portage, Sandusky, Huron, Vermilion, and Black Rivers. They drain an area of 4,109 square miles, with a population of 600,000. The principal cities are Lorain, Elyria, and Sandusky.

Hydrology

The rivers within this area are not hydraulically controlled to any great extent other than an occasional run-of-the-river dam. Low flows as measured at the U.S. Geological Survey gage nearest to the Lake are as follows: Portage 2.5 mgd; Sandusky, 21.5 mgd; Huron, 10.4 mgd; Vermilion, 7.2 mgd; Black, 1.6 mgd.

Economic Aspects

The economy of the area is diversified. Agriculture is predominant, with farm lands occupying 91 per cent of the basin. Industry is widespread throughout; heavy industry is concentrated in the Elyria-Lorain area on the Black River. Clay, glass, and stone products predominate in the western portion of the basin, while steel and transportation are important farther east.

Water Use

Inland surface waters supply 13 mgd to municipalities; wells supply another 5 mgd; and Lake Erie supplies 35 mgd.

Industrial

Industrial water use in the Western Ohio Basin is 227 mgd, and water used in power generation (exclusive of hydroelectric power) is 521 mgd. Of the total industrial water used in the basin, 7 mgd is used in each of the Portage and Sandusky River Basins and 220 mgd is used in the Huron to Black River Basin. With the exception of power generation, inland surface water and backwaters of Lake Erie supply 99 per cent of the demand.

Waterborne Commerce

Waterborne commerce in the Western Ohio area is served by the port facilities of Lorain at the mouth of the Black River, Huron at the mouth of the Huron River, and Sandusky at Sandusky Bay. These three ports account for 9 per cent of the tonnage moved through Lake Erie ports. No commercial navigation exists above the mouths of these rivers.

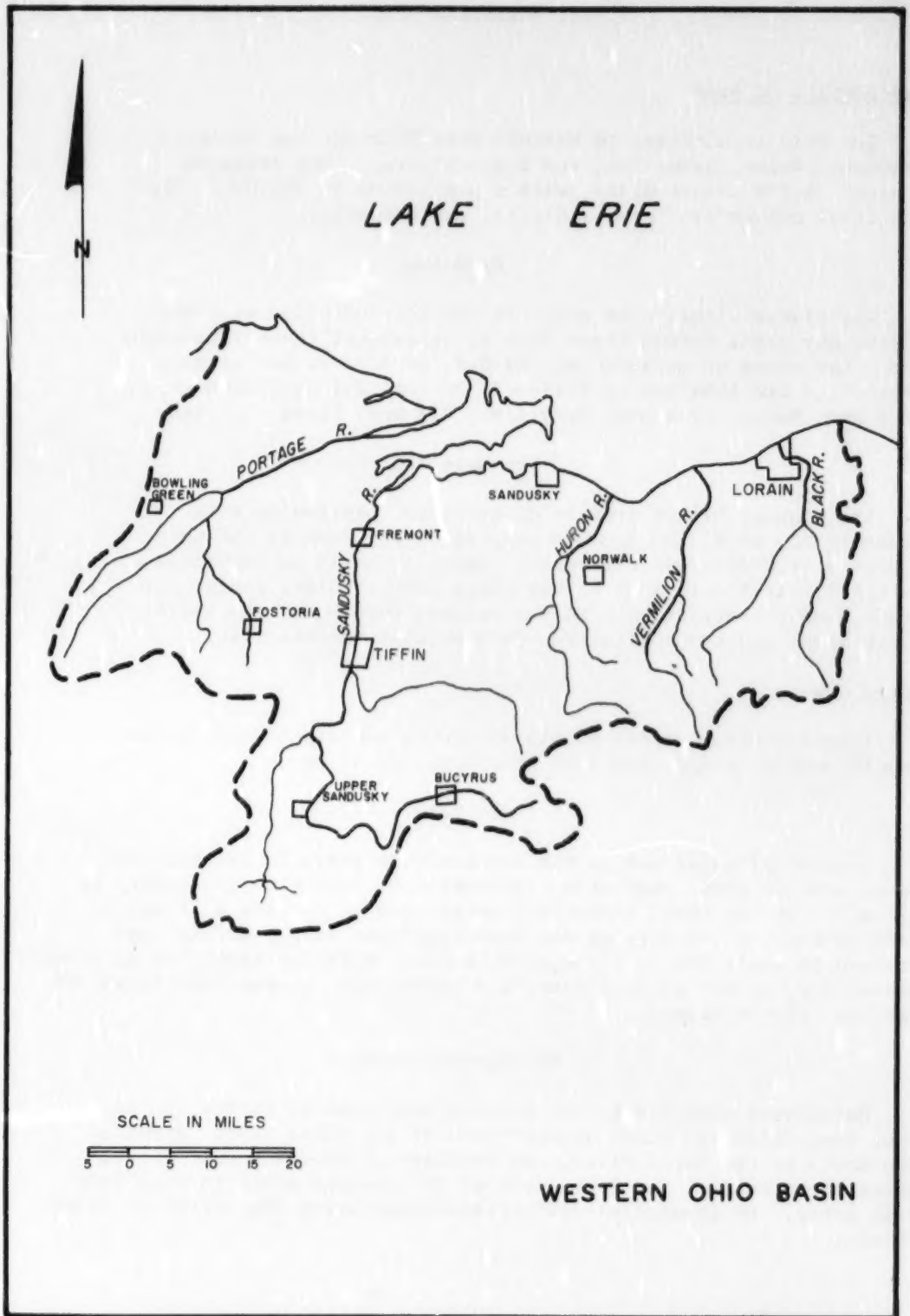
LAKE ERIE
N
PORTAGE R.
BOWLING GREEN
SANDUSKY R.
SANDUSKY
FREMONT
HURON R.
NORWALK
VERMILION R.
LORAIN
BLACK R.
FOSTORIA
SANDUSKY
TIFFIN
UPPER SANDUSKY
BUCYRUS
SCALE IN MILES
5 0 5 10 15 20
WESTERN OHIO BASIN

FIGURE III - 1

Recreation

The Sandusky Bay-Western Islands area is one of Ohio's principal recreational sites. Three state parks, a state beach, and a state reserve are located there.

Other bathing beaches and numerous boat marinas are located there and along the abutting shoreline of Lake Erie. There are no extensively developed recreational areas inland from the Lake.

Where the streams flow through communities, some municipal park facilities have been developed. Many historic sites are also found along the banks of these rivers.

Esthetics

The upstream reaches of these rivers flow through predominantly farm lands. As the streams flow toward the Lake through urban areas, the rivers become increasingly degraded so that their color has changed from blue to brown by the time they reach the Lake. Some of the color results from land erosion and industrial pollution.

In the navigation channel of the Black River, oil slicks on the water surface detract from the value of the adjacent properties.

Sources of Wastes

There are 170,000 people served by 22 secondary treatment plants and 141,000 people served by 11 primary plants. Forty-four thousand people are not served by any central treatment plant. Of the 27 industries located within the basin, two have inadequate treatment facilities according to the Ohio Department of Health.

DO - BOD Relationships

During periods of low flow the dissolved oxygen of the Sandusky River drops to less than 4.0 mg/l below Upper Sandusky, Tiffin, and Fremont. Forty per cent of the samples collected at the critical point below Upper Sandusky showed oxygen concentrations of less than 4.0 mg/l. On three occasions there was no measurable oxygen, and the BOD reached 39.0 mg/l. Intensive sampling programs below Tiffin and Fremont revealed that, during the low flow period and under normal loadings from the treatment plants, the DO concentrations approached 1.0 mg/l.

There are similar problems on the Black River from Oberlin to the lake-affected area in Lorain. The 1964 summer average of dissolved oxygen for this reach was 2 mg/l. Below Elyria, the average 5-day BOD was 20 mg/l.

Phenols

Along the heavy manufacturing area of the Black River the phenols averaged 9.8 µg/l during 1964 and ranged from 0.4 µg/l to 65.9 µg/l.

Land Runoff

Drainage and soil conditions in the flat areas are such that the fields are underlaid with drainage tile. Rural runoff to the Sandusky River carries with it sediment which amounts to over 100,000 tons per month during the spring. Nutrients present in the soil and from the application of approximately 180,000 tons of fertilizer annually to the basin provide the algae and other aquatic growths with ample supplies of nitrogen and phosphorus and the resulting growths completely blanket the Black River.

Microbiological

Sewage pollution, as indicated by total coliform densities, is prevalent throughout most of the basin. On the Portage River, median coliform density during the summer and fall of 1964 was 130,000 organisms per 100 ml. The fecal coliform density was 21,000 organisms per 100 ml.

The Sandusky River had a median coliform density of 190,000 organisms per 100 ml below Fremont for the months of October and November, 1964. In Sandusky Bay at the mouth of the river, the median coliform density was less than 1,000 organisms per 100 ml but had a high of 1,300 organisms per 100 ml.

Median coliform density in the Black River below the Elyria treatment plant was 300,000 organisms per 100 ml during the first three months of the year. During April and May, the median density was 140,000 organisms per 100 ml and the median fecal coliform density was 57,000 organisms per 100 ml.

Biology

Biological conditions in the Portage, Huron, and Vermilion Rivers are generally good except for the areas near the Lake which are degraded by siltation and local waste sources.

The Sandusky River below Upper Sandusky, Tiffin, and Fremont shows evidences of biological degradation. All pollution sensitive bottom-dwelling animals are absent below each area. Between Tiffin and Fremont, the nutrient-rich waters support dense growths of attached algae. Between Oberlin and the mouth of the Black River, biological conditions typical of a polluted stream are found.

Effects on the Lake

All the wastes emanating from the rivers in the western basin are diluted to the background concentrations of the Lake within a mile of the shoreline. However, the microbiological studies have shown that the bacterial pollution moves along the shore causing coliform densities to average 4,000 organisms per 100 ml east of Lorain. Average densities near Vermilion were 1,000 organisms per 100 ml.

Recommended Actions

The recommendations for pollution abatement set forth in Chapter I, Part I, are to be adopted where applicable in the Western Ohio Basin. In addition, it is recommended that the following industrial plants take the necessary actions listed:

Industry	Necessary Action
General Motors Corporation Ternstedt Division	Cyanide and metal reduction
Swift and Company	Oil removal
General Electric Company	Treatment of sewage
Bechtel-McLauglin	Chromium reduction
The Baltimore and Ohio Railroad Company	Oil removal

IV - ROCKY RIVER BASIN

Description of Area

The Rocky River is located in northeastern Ohio and flows into the central basin of Lake Erie. It carries the drainage from farm lands, small cities, and the western part of metropolitan Cleveland.

The upper 35 miles of the river system is composed of two separate streams, the East Branch with its headwaters near Hinckley and the West Branch with its headwaters near Medina. The two streams meet at Berea and flow 12 miles to the Lake. Approximately 30 miles of this river system flow through the Cleveland Metropolitan Park.

The land area of the Rocky River basin is 44 percent urban. Lands used directly for farming activities occupy 33 percent of the area, while other rural lands such as woodland occupies the remaining 23 percent of the area.

Although reservoirs located on both branches of the river regulate flow, the discharge of wastes from 15 sources supply the greatest part of the dry weather flow. The low flow at the United States Geological Survey gage at Berea is 3.9 mgd.

Water Uses

Municipal and Industrial

Medina and Berea are the only municipalities using the Rocky River for water supplies. They draw an average of 1.7 mgd. No industries are known to withdraw water from the river.

Recreation

The Rocky River flows through Cleveland Metropolitan Park from near the Cuyahoga County line (on the East Branch) to Lake Erie where extensive recreational use is made of the River. Two marinas are located near its mouth. Hinckley and Lester Lakes afford good recreational sites which are regularly used.

Esthetics

Since much of the lower Rocky River flows through a much-used Metropolitan Park, the poor esthetic character of the stream reduces the park's value as a recreational area.

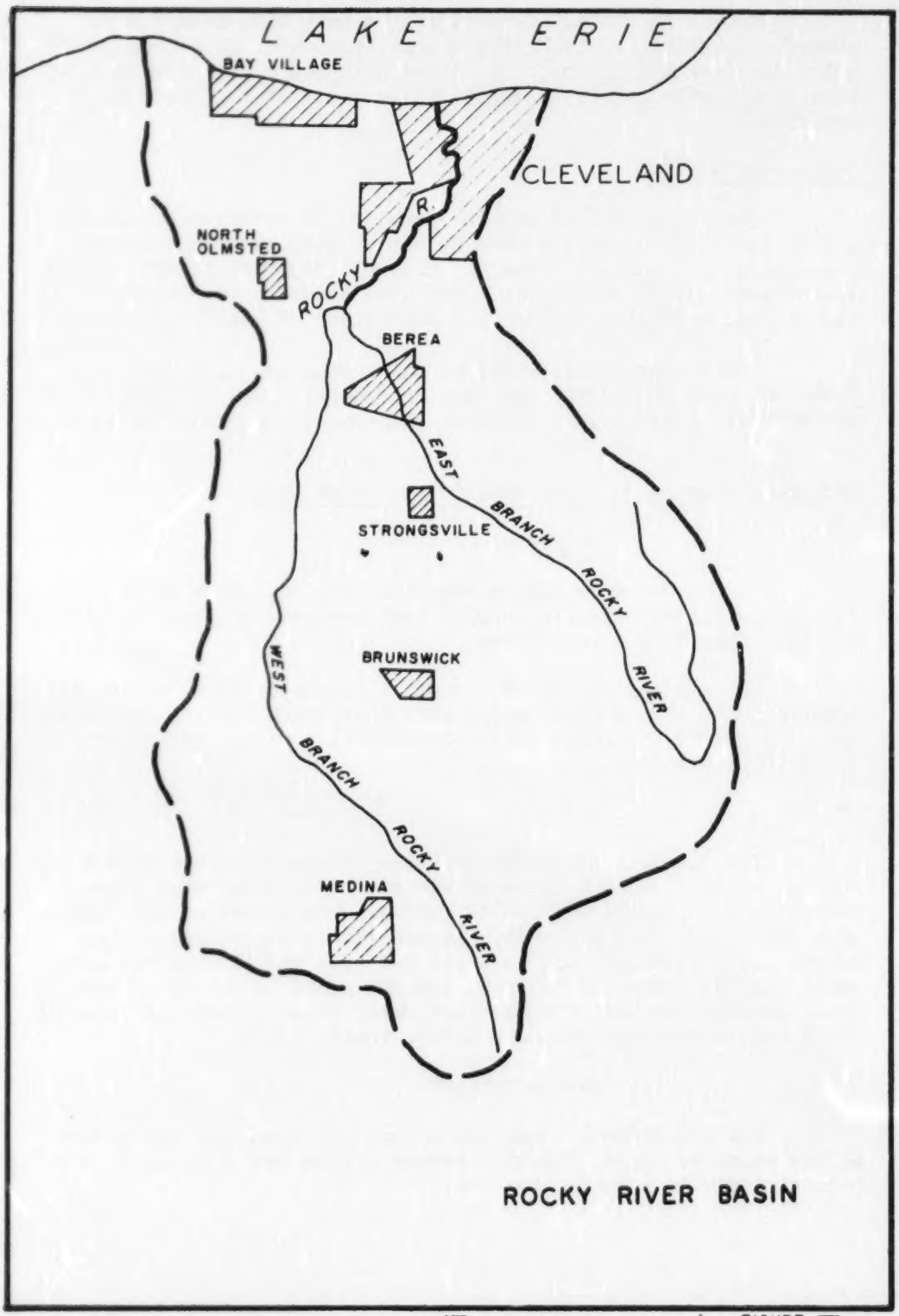
LAKE ERIE
BAY VILLAGE
CLEVELAND
R.
NORTH OLMSTED
ROCKY
BEREA
EAST
BRANCH
ROCKY
RIVER
STRONGSVILLE
BRUNSWICK
WEST
BRANCH
ROCKY
RIVER
MEDINA
ROCKY RIVER BASIN

FIGURE IV - 1

Debris and floating fecal solids have been observed at numerous locations. During the summer, the water is a deep green color due to algal blooms. The lower 15 miles of the stream often reek with a characteristic septic sewage odor, during periods of low flow.

Sources of Wastes

There are 129,000 people served by 20 secondary treatment plants and 45,000 people served by two primary plants. Fourteen thousand people are not served by central treatment plants. Three industries located within the basin have adequate treatment facilities, according to the Ohio Department of Health.

The average daily loads to the stream are as follows: 7,300 lbs./day BOD; [illegible],400 lbs./day phosphate; 2,000 lbs./day nitrate-nitrogen; 119,000 lbs./day chlorides; 5 lbs./day phenols.

Effects of Wastes on Water Quality and Water Uses

Microbiological

Discharges from sewage treatment plants, storm water overflows, and ditches carrying septic tank drainage are causing high coliform densities in the river.

The studies on the main stem of the Rocky River above the lake-affected area showed sewage pollution which impairs the river use as a recreation area. Coliform densities range from 55,000 to 1,000,000 per 100 ml.

Biology

The nutrients from the upstream sewage treatment plants fertilize the impounded areas of the stream so that large algal blooms develop during the summer months. The rooted aquatic weeds also increase. This plant life causes nuisance problems in the Metropolitan Park, as well as taste and odor problems in the Berea water supply. Slow-flowing and stagnant pools in the river provide ideal breeding areas for mosquitoes which create a serious nuisance condition in the park and surrounding areas.

Sewage Outfalls

The pollutional loads imposed on the river are manifested at its mouth by odors, floating sewage solids, and scum which are objectionable in a recreation area.

The organic load to the river has depleted the oxygen concentration below 4 mg/l as much as 50 percent of the time during the summer. Only local areas of pollution existed below waste inputs in the upper reaches of the river, the average BOD was greater than 4 mg/l throughout.

Recommended Actions

The recommendations for pollution abatement set forth in Chapter I, Part I are to be adopted where applicable in the Rocky River Basin. In addition, it is recommended that the following specific actions be taken:

1. A master sewerage plan be prepared for the Cleveland metropolitan area, including Cleveland, its suburbs, and rapidly developing urban lands- and an appropriate regional organization be given authority and responsibility for its implementation.

V - CUYAHOGA RIVER BASIN AND CLEVELAND LAKEFRONT

Area Description

The Cuyahoga River is located in northeastern Ohio where it drains the rural districts of Geauga and Portage Counties and the urban areas of Akron and Cleveland. Although the Cuyahoga basin represents only 3 per cent of the land area in the Lake Erie basin, 19 per cent of the entire basin's population live there.

Rising in the farm lands of Geauga County, the Cuyahoga River meanders for 103 miles through gorges and flat lands into the central basin of Lake Erie. Its network of tributaries drains an area of 813 square miles. Because of the many impoundments of its upstream waters, the river moves sluggishly until it reaches the Akron metropolitan area. Here, it becomes a rapidly flowing stream and continues this way to the navigation channel in Cleveland. In the navigation channel, the river again moves slowly toward Lake Erie. The fall of the upper Cuyahoga River is 9 feet per mile in a shallow channel cut through glacial drift. At Cuyahoga Falls, the river falls 220 feet in 1.5 miles through a sandstone gorge. The lower Cuyahoga River flows through a wide preglacial valley with a fall of 6 feet per mile.

Except for its upper reaches, much of the Cuyahoga Basin is highly urbanized. Cleveland and Akron with their expanding suburban communities occupy large sections of the basin. An estimated thirty-five per cent is forest land that lies in the upper Cuyahoga watershed and in the metropolitan parks of Cleveland and Akron. Idle lands occupy about fifteen per cent.

The lakefront in both the western and eastern portions is characterized by bluffs 50-70 feet in height and a narrow beach area. Within the Cleveland city limits, however, the bluffs decrease and become virtually nonexistent. Along this stretch there are wide beaches and many artificial works, the most prominent of which is the five-mile Federal Breakwater.

There are several small streams which drain the eastern section of Cleveland directly to Lake Erie. The largest of these are Euclid Creek, Doan Brook, and Dugway Brook.

Of the almost 31 miles of lake frontage in Cuyahoga County, 46% is occupied by housing, 16% by private (restricted) recreation, 15% by public recreation, 6% each by utilities and institutions, and 3% each by commerce and port facilities.

Flows in the Cuyahoga River are fairly high, due in a large measure to reservoirs in the upper watershed. Low flow at United States Geological Survey gage just upstream of Cleveland is 154 cfs.

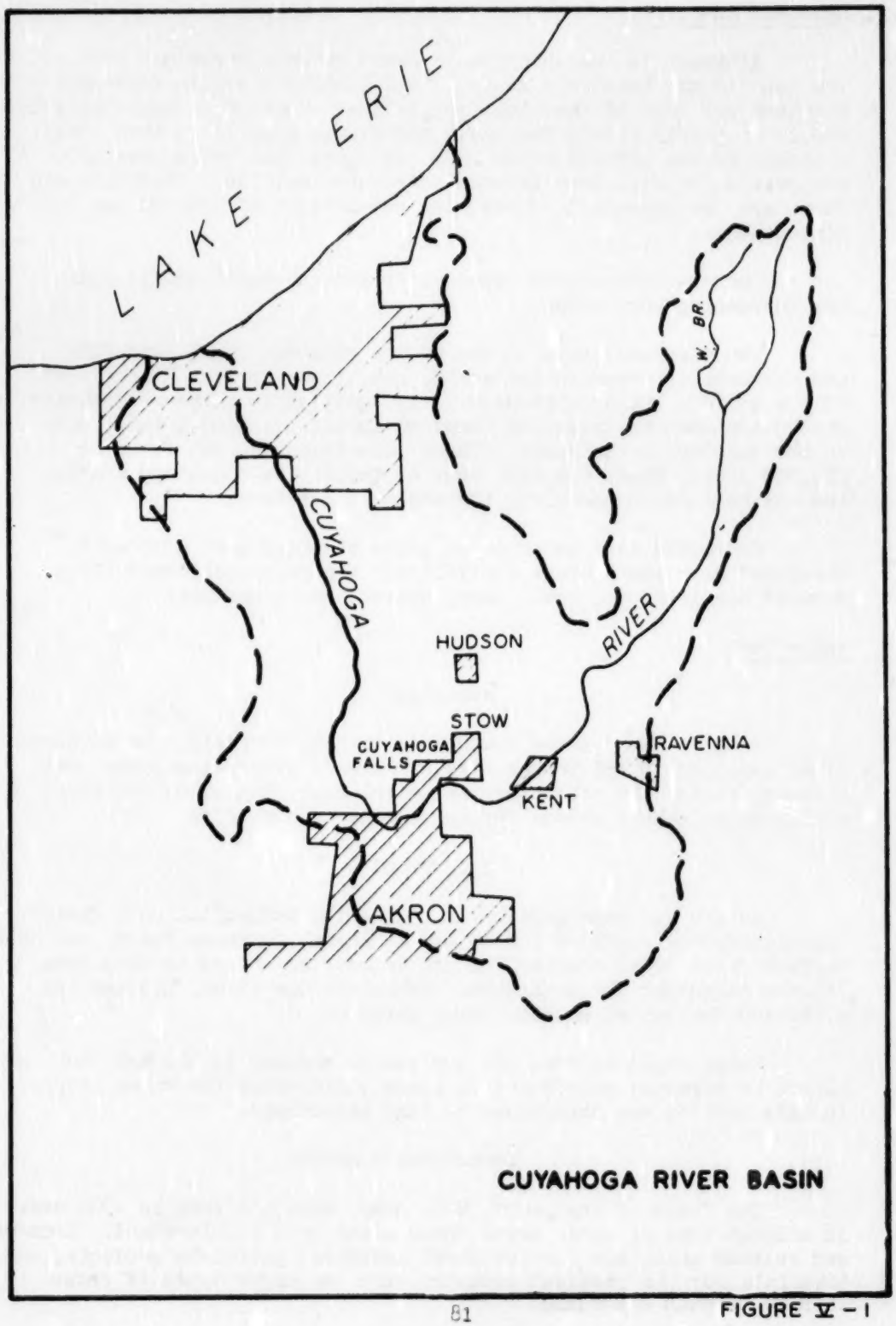
LAKE ERIE
CLEVELAND
CUYAHOGA
RIVER
W. BR.
HUDSON
STOW
CUYAHOGA FALLS
KENT
RAVENNA
AKRON
CUYAHOGA RIVER BASIN

FIGURE V - 1

Economic Aspects

Although the Cuyahoga Basin contains only three per cent of the land in the Lake Erie Basin, its 1.9 million people represent nineteen per cent of the total population. Forty-nine municipalities wholly or partly within the basin contribute heavily to this total. A steady growth pattern since 1900 indicates that by the year 2000 the population will have climbed over three million. Cleveland and Akron are the principal cities with populations of 876,000 and 290,000, respectively.

The economic growth expected within the basin should follow the increasing population.

The Cleveland area is one of the greatest steel producing and fabricating areas in the world, and Akron supplies 75 per cent of the world's rubber tire needs. In addition to these two industries, automotive manufacturing and chemical industries play a large role in the economy of the basin. These industries account for over 225,000 jobs. There are more than 65 industries operating within the Cuyahoga Basin and along the adjacent lakefront.

Cleveland is a major Great Lakes shipping port with well developed dock and storage facilities. The principal commodities handled are iron ore, coal, sand, gravel, and limestone.

Water Uses

Municipal

From its headwaters downstream to Lake Rockwell, the Cuyahoga River supplies 50 mgd to the city of Akron's filtration plant. At Cuyahoga Falls, the only other municipal user, the river recharges a well water supply system during periods of high flow.

Industrial

In the upstream portion of the basin, industrial well fields tap underground supplies for 18 mgd at Akron, Cuyahoga Falls, and Kent. Surface water meets another 200 mgd industrial demand in this area. Between Akron and the navigation channel in Cleveland, 120 mgd are withdrawn for varied manufacturing purposes.

Water supplied from the navigation channel is 300 mgd, but this cannot be directly attributed to river yield since the water levels in this section are determined by lake elevations.

Waterborne Commerce

The Corps of Engineers, U.S. Army, reported that in 1962 over 16 million tons of cargo moved through the port of Cleveland. Iron ore and related materials for the steel industry, petroleum products, and materials for the chemical industry were the major types of cargo shipped through Cleveland.

Recreation

The upstream sections of the river are used for fishing and boating. This area supports many species of fish. Below Lake Rockwell, the species of fish become less desirable and the quantities decrease. Reaches of the river below Akron are unsuitable for all types of water recreation.

Along the Cleveland metropolitan lakefront there are 10 public beaches and several boat marinas. The city has adopted a "swim if you must" bathing beach policy, because of the high coliform densities in the nearshore zone.

Rural

In rural areas, the primary water supplies are drilled wells. Most of the farms support dairy herds. Water used for irrigation is negligible.

Esthetics

Debris-filled, oil-slicked, dirty-looking waterways defines the Cuyahoga River at any place along its course. Some reaches are blocked completely by dead trees and stumps, while the banks are dotted with many small dumps. Trash ranging from tin cans to refrigerators is a common sight in the river. In the navigation channel where the Cuyahoga flows through Cleveland even more debris exists and the water surface often becomes black with oil from the industrial outfalls. As long as these situations remain, the Cuyahoga will be a liability to the cities it serves and adjacent property owners, instead of an asset.

The lakefront is littered with debris. The discolored water and floating debris, particularly behind the federal breakwater, have reduced the esthetic value usually associated with the free, limitless beauty of a natural body of water. The debris consists of discarded lumber, tree limbs, metal cans, paper products, dead fish, oil slicks, grease, and scum.

Sources of Wastes

Thirty-five sewage treatment plants discharge to the Cuyahoga River. There are 886,000 people served by 29 secondary treatment plants and 37,000 people served by 6 primary plants. Thirty-three thousand people are not served by any central treatment plant at all.

Cleveland's Southerly Sewage Treatment Plant and Akron's Water Pollution Control Station which together treat the wastes from 824,000 [illegible] have been classified inadequate by the Ohio Department of Health. [illegible] 41 industries located within the basin, 19 have inadequate [illegible] eatment facilities, according to the Ohio Department of Health.

The average daily loads to the navigation channel at Cleveland are as follows: 80,000 lbs/day BOD ;3,500 lbs/day phosphate; 42,500 lbs/day ammonia nitrogen; 9,100 lbs/day nitrate-nitrogen; and 104 lbs/day phenols.

There are three large sewage treatment plants that discharge directly to the Lake along the Cleveland waterfront.

There are 604,000 people served by the Cleveland Easterly Plant (secondary treatment) and 327,000 people served by the primary sewage treatment facilities of Cleveland Westerly and Euclid.

Most industries in the lakefront area discharge to sanitary sewers. There are two industries under permit to the State of Ohio to discharge directly to the Lake or to the small streams which drain eastern Cleveland. However, there are 20 known industries that discharge to the Greater Cleveland Lakefront. The pollutional significance of these discharges have not been determined.

A substantial portion of the City of Cleveland is served by a combined sewer system. With the construction of sewage treatment plants, combined sewers were connected to new interceptor sewers to collect the dry weather flow with some allowance for storm waters. Overflow structures were provided at most junctures between the combined sewers and the interceptor so that heavy storm water flows would discharge directly to the nearest water course.

The City of Cleveland has approximately 383 combined sewer overflow structures which discharge sewage and industrial wastes mixed with storm water during periods of storm runoff. There are more than one hundred and thirty storm water overflow devices that discharge to the Lake or small streams in eastern Cleveland. Over two hundred and fifty additional overflow devices discharge to the Cuyahoga River or small tributaries. A number of these overflow structures are continually malfunctioning and contribute a significant amount of sewage to the lakefront area.

Effects of Wastes on Water Quality and Water Uses - Cuyahoga River

DO-BOD Relationships

The dissolved oxygen concentration was critically low below Kent, Akron, and in the navigation channel in Cleveland. During 1964, oxygen concentrations downstream from Kent's sewage treatment plant ranged from a high of 9.25 mg/l in the winter to a low of 0.0$ mg/l in the summer. The DO below Akron's water pollution control station varied from 0.45 to 5.85 mg/l. In the navigation channel which is below Cleveland's Southerly Treatment Plant and amid the industrial

complex, values ranged between 0.0 mg/l and 1.20 mg/l. The five-day biochemical oxygen demands (BOD) average 10.2 mg/l, 11.3 mg/l and 8.9 mg/l, respectively, for these areas. Bottom dwelling animals were limited to midge larvae and sludgeworms in this section of the river.

Dugway Brook and Nine-mile Creek were sampled several times in 1963 and 1964 and showed indications of pollution. The dissolved oxygen was generally zero and the BOD varied from 9 to 30 mg/l.

Phenols

In 1964 phenol concentration increased from Lake Rockwell to Lake Erie. The concentration averaged 1.8 µg/l at Lake Rockwell, 7.2 µg/l at Akron, and 20.8 µg/l at Cleveland during the summer of 1964. In the navigation channel, phenol averaged 58.0 µg/l and the maximum was 175 µg/l.

Algae and Aquatic Plants

In the impounded waters above Kent, and between Kent and Akron, there are prolific growths of algae and aquatic weeds which create a nuisance condition and degrade the esthetic value of the river. Decomposition of these growths which are nourished by the effluents from the sewage treatment plants of Ravenna, Kent, and Stow exert an oxygen demand on the river.

The waters flowing from Lake Rockwell support a clean water community of bottom dwelling animals. Below Kent the population shifts to the pollution tolerant forms. Only pollution tolerant forms were found between Kent and the river mouth. In the lower Cuyahoga conditions were so severe that even the most tolerant forms were totally absent.

Microbiological

Excessive bacterial pollution of the Cuyahoga exists from its headwaters to its mouth. Median total coliform values per 100 ml ranged from a low of 9,200 organisms at Lake Rockwell to a high of 470,000 organisms at the head of the navigation channel. The fecal coliform to fecal streptococcus ratio varied from 1:1 to 10:1, indicating pollution from human origin. The human enteric pathogen study conducted in the Cleveland area showed 14 different species of Salmonella organisms. Salmonella was detected in 64.7 per cent sampled. These observations confirm the health hazard to humans contacting these highly polluted waters.

Debris and Oil

The fallen trees, trash, and debris make the waterway unsightly and unusable at many locations. Removal of this foreigh material would permit more extensive boating in the upper reaches. The debris along the lakefront detracts from the natural beauty of Lake Erie and is hazardous to the many boaters on the Lake.

The oil on the surface of the river throughout the navigation channel has fueled some large fires in the lower river. The problem has reached such proportion that fire breaks have been built to separate the surface waters into sections so that oil fires can be held within a certain area.

Effects of Wastes on Lakefront Water Quality and Water Uses

The breakwater acts as a holding basin for Cuyahoga River water. Depending on wind direction, water flows out of the breakwater through either the north or east outlets. Water within this basin tends to be of uniformly poor quality with relatively higher concentrations of chemical and microbiological pollutants nearer the river mouth.

At the river-Lake junction, dispersion or dilution of river water takes place. The dissolved oxygen values approach saturation, and other substances approach background concentrations of the Lake. Conductivity values show no appreciable concentration gradients one-half mile beyond the breakwall.

The coliform concentrations decreased from a median of 470,000 organisms per 100 ml at the head of the navigation channel to about 5,000 per 100 ml at the mouth of the breakwall. All stations inside the breakwater exhibited a very limited variety of tolerant bottom animals. Only sludgeworms, fingernail clams, nematodes, and bloodworms were found in this area. Sludgeworms, which thrive on organic matter, averaged 400,000 per square meter in the harbor. Outside the breakwater a slightly more diverse fauna was found which included less tolerant leeches, pulmonate and gill-breathing snails, and aquatic sowbugs in addition to the forms found inside the breakwater. No sensitive mayfly nymphs, caddis fly larvae, scuds and unionid clams were found at any of the stations sampled. The bottom type, depth, and temperature here are suitable for all of these intolerant groups, and they occur under similar conditions in other parts of Lake Erie.

The U.S. Corps of Engineers routinely dredge the shipping channels in Cleveland Harbor and the Cuyahoga River. The material dredged from these areas until recently was deposited about eight miles out in the Lake but is now deposited on an experimental basis near the north side of the east breakwall. A narrow band of microbiologically polluted water exists along the shore and behind the breakwater. There is a sharp break between this band and the offshore waters, rather than a gradual dispersion. Thus a condition exists where the beach areas are highly polluted, while the water a distance of one-half mile from shore is suitable for recreation and other purposes.

The results of a microbiological study of bathing beach areas this past summer by the Cities of Cleveland and

The oil on the surface of the river throughout the navigation channel has fueled some large fires in the lower river. The problem has reached such proportion that fire breaks have been built to separate the surface waters into sections so that oil fires can be held within a certain area.

Effects of Wastes on Lakefront Water Quality and Water Uses

The breakwater acts as a holding basin for Cuyahoga River water. Depending on wind direction, water flows out of the breakwater through either the north or east outlets. Water within this basin tends to be of uniformly poor quality with relatively higher concentrations of chemical and microbiological pollutants nearer the river mouth.

At the river-Lake junction, dispersion or dilution of river water takes place. The dissolved oxygen values approach saturation, and other substances approach background concentrations of the Lake. Conductivity values show no appreciable concentration gradients one-half mile beyond the breakwall.

The coliform concentrations decreased from a median of 470,000 organisms per 100 ml at the head of the navigation channel to about 5,000 per 100 ml at the mouth of the breakwall. All stations inside the breakwater exhibited a very limited variety of tolerant bottom animals. Only sludgeworms, fingernail clams, nematodes, and bloodworms were found in this area. Sludgeworms, which thrive on organic matter, averaged 400,000 per square meter in the harbor. Outside the breakwater a slightly more diverse fauna was found which included less tolerant leeches, pulmonate and gill-breathing snails, and aquatic sowbugs in addition to the forms found inside the breakwater. No sensitive mayfly nymphs, caddis fly larvae, scuds and unionid clams were found at any of the stations sampled. The bottom type, depth, and temperature here are suitable for all of these intolerant groups, and they occur under similar conditions in other parts of Lake Erie.

The U.S. Corps of Engineers routinely dredge the shipping channels in Cleveland Harbor and the Cuyahoga River. The material dredged from these areas until recently was deposited about eight miles out in the Lake but is now deposited on an experimental basis near the north side of the east breakwall. A narrow band of microbiologically polluted water exists along the shore and behind the breakwater. There is a sharp break between this band and the offshore waters, rather than a gradual dispersion. Thus a condition exists where the beach areas are highly polluted, while the water a distance of one-half mile from shore is suitable for recreation and other purposes.

The results of a microbiological study of bathing beach areas this past summer by the Cities of Cleveland and

Euclid and the Public Health Service are summarized below. Median values are recorded in this table. These data show the high counts observed on all beaches and these beaches all remained open during the study period.

BATHING BEACH STUDY
CLEVELAND LAKEFRONT

City	Beach	Median	Total Coliform Count % greater than 1,000/100 ml
Cleveland, Ohio	Perkins	3,400	65%
Cleveland, Ohio	Edgewater	5,000	76%
Cleveland, Ohio	White City	6,100	91%
Cleveland, Ohio	Wildwood	700	40%
Euclid, Ohio	E. 199 Street	7,400	92%
Euclid, Ohio	E. 215 Street	9,200	90%
Euclid, Ohio	E. 222 Street	12,000	86%
Euclid, Ohio	E. 225 Street	12,000	86%
Euclid, Ohio	E. 252 Street	6,100	78%
Euclid, Ohio	Lloyd Road	4,000	82%

Recommended Actions

The recommendations for pollution abatement set forth in Chapter I, Part 1, are to be adopted where applicable in the Cuyahoga River Basin. In addition, it is recommended that the following specific actions be taken:

1. The following industrial plants take the necessary actions listed:

Industry	Necessary Action
Republic Steel	Removal of spent sulfate pickling solutions; Increased oil and solids removal
Standard Oil Corp.	Oil removal
U.S. Steel Corp.	Removal of spent sulfate pickling solutions; Increased solids removal
E. I. DuPont	Metals reduction
Jones and Laughlin Steel Company	Removal of spent sulfate pickling solutions

Industry	Necessary Action
Harshaw Chemical Company	Metals reduction
Cuyahoga Meat Company	Reduction of solids and BOD
Masters Anodizers and Platers, Inc.	Metal reduction
Sonoco Products Company	Reduction of solids and BOD
Thompson Ramo Woolridge	Metals reduction

2. A master sewerage plan be prepared for the Cleveland metropolitan area, including Cleveland, its suburbs, and rapidly developing urban lands -- and an appropriate regional organization be given authority and responsibility for its implementation.

3. Similar action to 2 be taken in the Akron metropolitan area.

VI - EASTERN OHIO

Area Description

The principal tributaries to Lake Erie in Northeastern Ohio are the Grand River, Ashtabula River, and Conneaut Creek. The combined drainage basins cover an area of 1,208 square miles, of which 86 per cent is rural. The population of 180,000 is concentrated along Lake Erie in Lake County. Manufacturers of chemical and allied products and other diversified industries are found near the mouth of the three major streams. The ports of Fairport Harbor, Ashtabula and Conneaut, at the mouth of the three major streams, handle 11 per cent of Lake Erie commerce. Dairying, greenhouses and nurseries are prominent agricultural pursuits in the basin.

Water Uses

Municipal Water Supply

Lake Erie provides 83 per cent of the municipal water supply in the Basin. Only two communities, Geneva and Jefferson, withdraw municipal water from inland surface streams. These communities located in the Grand River Basin, withdraw 0.9 mgd from the Grand River and 0.25 mgd from Mill Creek, respectively. Only 1.43 mgd of municipal water supplies are taken from ground water.

Industrial Water Use

Industrial water use in the Northeastern Ohio Basin totaled 290 mgd in 1955 and water used in power generation (exclusive of hydroelectric power) totaled 540 mgd. Primary metal industries used 180 mgd, 60 per cent, chemical and allied products industries used 109 mgd, 37 per cent total. Lake Erie furnished 98 per cent of the industrial water use. Sixty-six per cent was used by industries at Fairport Harbor. The major industrial water supply withdrawn from surface streams was taken from the Grand River at the city of Grand River. Cooling water accounted for 93 per cent of industrial water usage.

Shoreline Recreation

The five main shoreline recreation areas in Lake County are Mentor Township Park, Headlands State Park, Fairport Beach, Painesville Township Park, and Madison Township Park. These beach areas are used for swimming, boating, water skiing, and fishing. These beaches serve the people of Cleveland and its suburbs as well as local residents. This area has partially replaced the Cleveland lakefront as a recreation center.

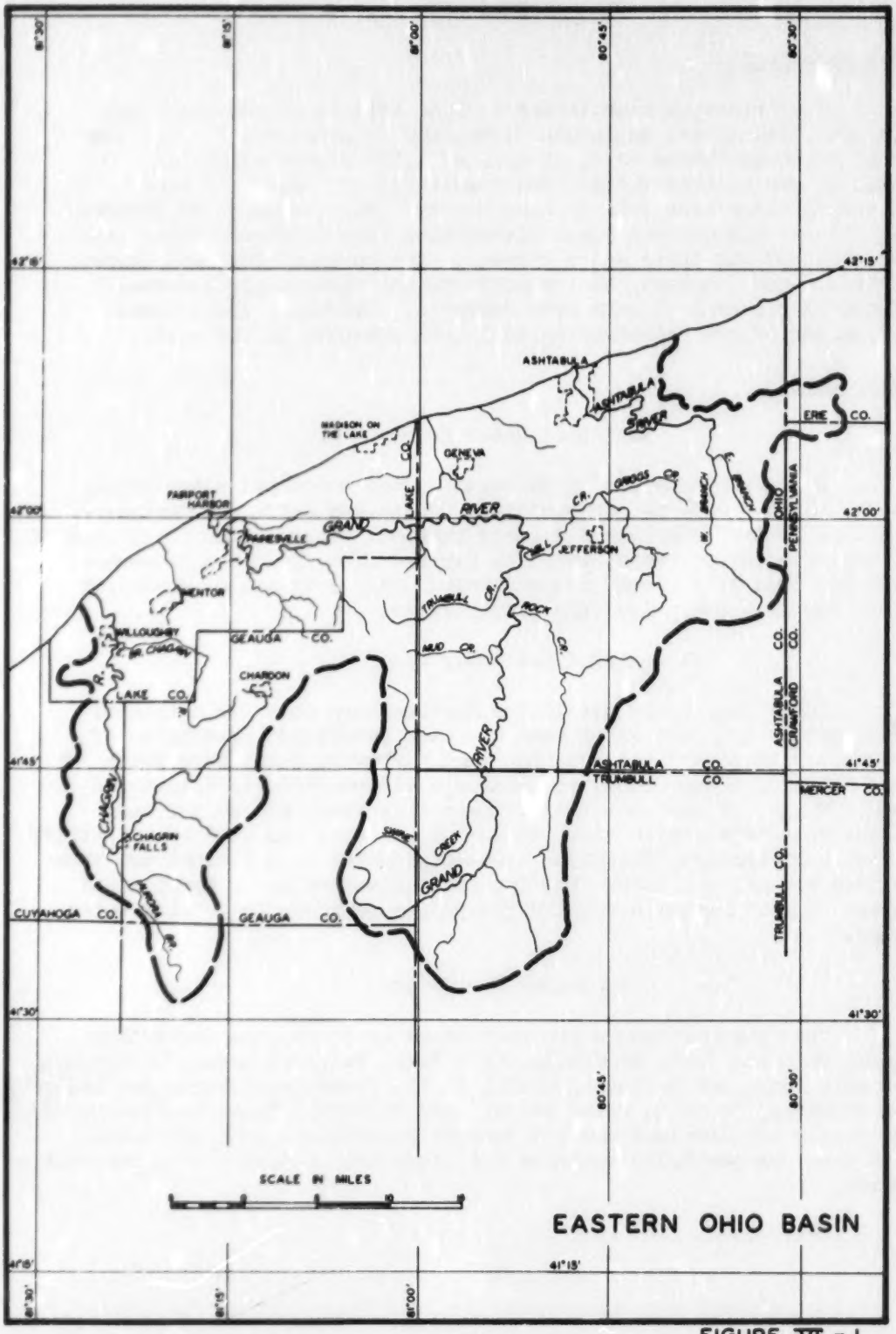
ASHTABULA
ASHTABULA RIVER
ERIE CO.
MADISON ON THE LAKE
GENEVA
LAKE CO.
GRIGGS CR.
FAIRPORT HARBOR
GRAND RIVER
PAINESVILLE
JEFFERSON
OHIO
PENNSYLVANIA
MENTOR
TRUMBULL CR.
ROCK CR.
WILLOUGHBY
GEAUGA CO.
MUD CR.
CHARDON
LAKE CO.
ASHTABULA CO.
CRAWFORD CO.
ASHTABULA CO.
TRUMBULL CO.
MERCER CO.
CHAGRIN
CHAGRIN FALLS
SHIRE CREEK
GRAND
CUYAHOGA CO.
GEAUGA CO.
TRUMBULL CO.
SCALE IN MILES
EASTERN OHIO BASIN

FIGURE VI - 1

In the summer of 1964, the Lake County Health Department conducted a study of these five beach areas. The median coliform densities ranged from 130 to 1,000 organisms per 100 ml at Headlands State Park and Painesville Township Park, respectively. It was found in many cases that the coliform density increased during periods of rainfall and high or gusty winds.

Principal Sources of Waste

A total of 60,000 population equivalents (PE) of municipal waste is treated by sewage treatment plants. Of this total, 20,000 PE are treated by facilities tributary directly to Lake Erie. Approximately 20,000 people use septic tank disposal systems.

Principal discharges directly to Lake Erie are from the lakefront communities of Ashtabula and Conneaut and from two Lake County sewer districts. All employ primary waste treatment.

All inland and upstream municipal discharges are minor because of small population centers, secondary treatment, or discharge to the ground.

Data on the discharges of industrial wastes to the Eastern Ohio tributaries are not complete. From partial data obtained from the Ohio State Department of Health, 19 principal industrial discharges have been tabulated.

Chemical industries of the Basin are engaged in processing sodium chloride and related products, and primary metals such as titanium and aluminum. They discharge an undetermined amount of chloride, metals, and other chemicals to the surface streams.

Except for chemical industries, the only major water user is a synthetic textile plant, the Industrial Rayon Company, which discharges its wastes to Lake Erie. The flow reported for this industry is 3.5 mgd and the discharge contains approximately 20 tons/day of total solids, 800 pounds per day of BOD, along with metals, oil, and other chemicals.

Waste discharges from metal finishing operations in the Basin are minor in flow quantities, compared to the chemical and synthetic textile industries but improperly treated wastes are extremely toxic. They consist of acid and alkaline cleaning compounds, cyanide, chrome, and other heavy metals. The industries discharge to minor tributaries of Lake Erie where little flow is available for dilution.

Grand River

Three municipal treatment plants provide primary treatment for 19,460 PE, and three plants provide secondary treatment for 4,925 PE in the Grand River Basin. A total of 6,840 people in 14 communities are not served by collection and treatment systems.

Six major industries also discharge to the Grand River. These are: Diamond Alkali Company; Calhio Chemicals; Naugatuck Chemical; Metal Craft Company; A.E. Staley Manufacturing Company; and Welded Tubes, Incorporated.

In addition to process chemicals, the major contributions of these industries are chlorides and solids. The industrial waste data are inadequate to make an estimate of the loads contributed by these industries.

It is estimated that 94 mgd of the industrial water is returned to the Grand River, approximately 83 per cent is used as cooling water.

Ashtabula River

There are no sewerage systems in the Ashtabula River Basin. A total of 1,095 people in three Ohio communities reside in the basin.

Nine major industries discharge to Fields Brook which is tributary to the Ashtabula River in the City of Ashtabula. These industries are: Olin Mathieson; Cabot Titania Corporation Titania Dioxide Plant; Titania Tetrachloride Plant; Detres Chemical Industries, Chlorinated Solvents Division; Reactive Metals Sodium and Chlorine Plant; Reactive Metals Metal Reduction Plant; Reactive Metals Extrusion Plant; Diamond Alkali Company; and General Tire and Rubber Company, Chemical Division.

Conneaut Creek

Four municipal treatment plants, all in Pennsylvania, provide secondary treatment for 2,380 PE and discharge to Conneaut Creek. Five communities (7,190 people) are not served by sewerage systems. Two communities (5,130 people) are in Ohio and the three communities (2,060 people) are in Pennsylvania.

One major industry, Albro Packing Company in Springboro, Pennsylvania, is located in the Conneaut Creek basin.

Total to Lake Erie

The load contributed by the Grand River, as measured bi-weekly for one year at 2.3 miles above the mouth is presented below.

	Average Pounds per day
Chlorides	2,200,000
Biochemical Oxygen Demand	7,000
Phenols	75
Nitrogen Compounds	3,970

The actual load to Lake Erie is greater because an undetermined quantity of industrial wastes is discharged to the river below this sampling station. The flow could be as great as 100 mgd.

Loads from the Ashtabula River at the sampling station 3.3 miles from the mouth are as follows:

	Pounds per day
Chlorides	17,000
Biochemical Oxygen Demand	13,000
Phenols	1
Phosphate	55
Nitrogen Compounds	310

Effects of Wastes on Water Quality

Grand River

The lower three miles of the river are brightly colored, with hues ranging from bright green and yellow to black. The green and yellow colors result from chemical discharges, but the black color is attributed to fly ash discharges. The banks of the river in this reach are covered with a white sediment, from chemical discharges.

Chloride concentrations of 3,620 mg/l and 5,260 mg/l were found during the summer and fall of 1964, respectively, at mile point 2.3. This station is below the discharges of several large chemical industries. Above these industrial discharges the chloride concentrations were 40 mg/l and 44 mg/l, respectively.

The degradation of the Grand River is objectionable because the polluted water flows through an expanding urban area at the river mouth. The same sediments that were found along the river bank were also found on the sides of pleasure boats.

Coliform densities, less than 1,000 per 100 ml at the mouth of the river, do not indicate a health hazard. No dissolved oxygen problems were found in the chemically polluted Grand River and the highest seasonal BOD was only 5.0 mg/l. Median total coliform densities were found to be below 10,000 per 100 ml except immediately below the Fairport Harbor and Painesville sewage treatment plants where the median values were 67,000 and 150,000 per 100 ml during the summer and fall, respectively.

Between Painesville and the river mouth bottom dwelling organisms were limited to pollution-tolerant sludgeworms and bloodworms.

Ashtabula River

Above the city, the lowest dissolved oxygen concentration found was 6.6 mg/l and BOD averaged less than 2.9 mg/l. Median coliform densities in summer and fall were under 7,900 per 100 ml and under 750 per 100 ml in the winter and spring.

Median coliform densities of 43,000 and 250,000 per 100 ml were found at mile point 0.7 during the summer and fall.

The chemical and allied products industries at Ashtabula discharge their wastes into a large marshy area of Fields Brook creating a severe problem.

The dissolved oxygen concentration at mile point 2.3 was below 4 mg/l 25 per cent of the time during the summer, the lowest was 1.2 mg/l. The BOD average was 10 mg/l during October and November. Both of these conditions were obtained during the extremely low flow, 7 cfs, during the summer and 3 cfs during October and November.

Conneaut Creek

The only municipal waste discharges to Conneaut Creek are two secondary treatment plants in Pennsylvania which discharge only a total of 60 pounds of BOD per day.

A meat packing operation at Springboro, Pennsylvania, discharges approximately 140 pounds of BOD per day from a secondary treatment plant.

Effects on Lake

The effect of the Grand River on Lake Erie is noticeable up to two miles from shore. Sampling data indicate that there is density stratification as it enters the lake. Chloride concentrations which are high in the river averaged 107 mg/l at the entrance to the harbor and 40 to 50 mg/l outside the breakwall at the upper layer.

The Ashtabula River exerts an influence on the Lake as far as 1.5 miles from the river mouth, as evidenced by coliform levels. The median total coliform densities decreased from 41,000 to 150 per 100 ml. Offshore from Ashtabula, total coliform values in Lake Erie were less than 1 per 100 ml 60 per cent of the time. Within the harbor, median coliform densities were below 1,500 per 100 ml.

A median coliform value of 2,800 per 100 ml was found at the station offshore from the Ashtabula Sewage Treatment Plant.

The bottom dwelling animals outside of the harbor were similar in both number and kinds to adjacent inshore areas and no evidence of the River's effect could be determined more than half a mile from the mouth.

Generally, the waters of Lake Erie beaches in eastern Ohio are of satisfactory bacterial quality.

Recommended Actions

The recommendations for pollution abatement set forth in Chapter I, Part I are to be adopted where applicable in the Eastern Ohio Basin. In addition, it is recommended that the following specific actions be taken:

1. The following industrial plants take the necessary actions listed:

Industry	Necessary Action
Olin Mathieson	pH Control and Solids Reduction
Cabot Titania Corp.	Solids Reduction
Detrex Chemical Industry	Reduction of Iron and Chlorinated Hydrocarbon
Reactive Metals	Solids Reduction and pH Control
Diamond Alkali Co.	Solids Reduction
General Tire & Rubber Co.	Solids Reduction
Industrial Rayon Co.	Metals Reduction

Industry	Necessary Action
Cleveland Electric Illuminating Co. (Eastlake)	Solids Reduction

2. Master sewerage plans be prepared to guide development in areas where urbanization is taking place.

VII - DETROIT RIVER AND MICHIGAN TRIBUTARIES

Pollution of the Detroit River and Michigan waters of Lake Erie has been the subject of previous enforcement conferences. Specific recommendations were developed by the Detroit River-Lake Erie Project for all known sources of municipal and industrial wastes in the conference area. At the conference session held June 15-18, 1965, the Michigan Water Resources Commission agreed to implement the recommendations of the U. S. Department of Health, Education, and Welfare, as contained in the "Report on Pollution of the Detroit River, Michigan Waters of Lake Erie, and their Tributaries," April 1965.

The material in this chapter is an abstract of the "Summary, Conclusions, and Recommendations" volume of that report.

Description of the Area

The Detroit River, the Huron River, and the Raisin River are the principal Michigan tributaries to Lake Erie. The Detroit River is the connecting waterway between Lake St. Clair and Lake Erie, and is the International Boundary between the United States and Canada. The Detroit River flows in a southwesterly, then a southerly direction for about 31 miles from Windmill Point to its mouth at Lake Erie. The major tributary to the Detroit River is the Rouge River which discharges at Zug Island. The Huron River begins west of Detroit and flows in a southwesterly, then a southeasterly direction to its mouth at Pointe Mouillee near the mouth of the Detroit River. The Raisin River begins about 50 miles due west of Monroe and discharges to Lake Erie just below Monroe.

The Detroit River, outstanding among great waterways of the world, performs a number of important functions for the area. It provides a shipping channel for the heavy traffic through the Great Lakes, provides vast quantities of water for municipal and industrial purposes, and receives large volumes of untreated and partially treated sewage and industrial wastes. The Detroit River also provides, potentially, excellent opportunities for recreation.

The Detroit, Huron, and Raisin River Basin has a population of over 3.8 million people and a drainage area of 2,000 square miles. This area serves three important economic functions: agriculture, industry, and recreation. The inland area of the basin as well as the land bordering the western edge of Lake Erie is used for farming and recreation. There are at least 18 recreational areas and 63 marina facilities located along the Detroit River and the Michigan portion of Lake Erie. The Detroit area has developed into one of the most important industrial centers in the world. The automobile industry has been responsible for the rapid industrial growth in the Detroit area over the past 30 to 40 years, bringing in many related industries.

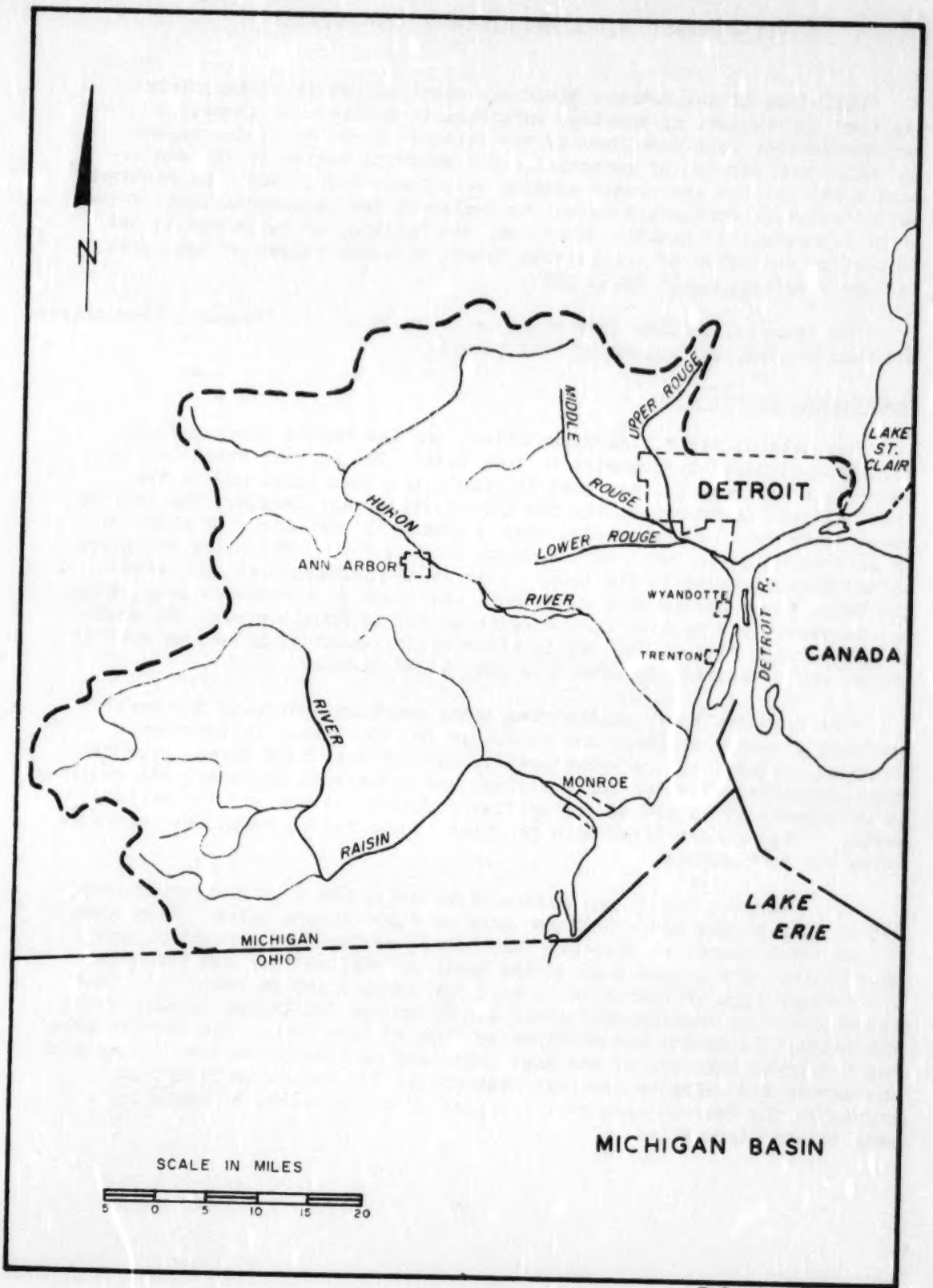
N
UPPER ROUGE
MIDDLE
ROUGE
LAKE ST. CLAIR
DETROIT
HURON
LOWER ROUGE
ANN ARBOR
RIVER
WYANDOTTE
DETROIT R.
TRENTON
CANADA
RIVER
MONROE
RAISIN
LAKE ERIE
MICHIGAN
OHIO
MICHIGAN BASIN
SCALE IN MILES
5 0 5 10 15 20

FIGURE VII - 1

Sources of Wastes

Every day more than 1.6 billion gallons of processing and cooling water flow into the Detroit River -- 1.1 billion gallons from industry and 540 million gallons from municipal sewage treatment plants. Huge quantities of waste constituents contained in this discharge change the Detroit River from a basically clean body of water at its head to a polluted one in its lower reaches. These waters are polluted bacteriologically, chemically, physically, and biologically, and contain excessive coliform densities as well as excessive quantities of phenols, iron, oil, ammonia, suspended solids, setteable solids, chlorides, nitrogen compounds, and phosphates.

The City of Detroit's main sewage treatment plant, serving more than 90 per cent of the people in the area, contributes 95 per cent of the municipal waste to the Detroit River and is also the major source of suspended solids, phenols, oil, inorganic nitrogen, phosphates, and biochemical oxygen demand in the river. Overflows from combined sewers in Detroit and its suburbs, carrying both stormwater and raw sewage, contribute to the degradation of the river.

In the upper Detroit River, the Great Lakes Steel Company and the Allied Chemical Corporation are the major sources of industrial wastes. The Ford Motor Company is the principal contributor of inorganic wastes to the Rouge River, and the Scott Paper Company is the principal contributors of organic wastes. Downriver industries contributing significant quantities of wastes are the Great Lakes Steel Corporation, the McLouth Steel Corporation, Pennsalt Chemical Corporation, and Wyandotte Chemical Corporation. On the Raisin River the leading polluters are the two Consolidated Paper Company mills, Monroe Paper Products Company, and the Union Bag-Camp Paper Company.

Other significant sources of pollution in the study area are overflows from combined sewers, municipal and industrial waste spills, and wastes from shorefront homes.

Effects of Wastes on Water Quality and Water Uses

Pollution of the Detroit River causes interference with municipal water supply, recreation, fish and wildlife propagation, and navigation. Two municipal water intakes are endangered by the high bacterial counts of the river. The rising chloride levels indicate potential future problems for industrial water usage. In addition, high concentrations of phenols and ammonia at the Wyandotte water intake have interfered with municipal water treatment by causing taste and odor problems and reducing the effectiveness of chlorination. Excessive quantities of chlorine are needed to reduce bacteria to a safe level.

All forms of water contact sports in the lower Detroit River are hazardous. Declining levels of dissolved oxygen in the lower Detroit River as it enters Lake Erie represent a threat to future water uses.

Bottom sludge deposits, oil, and toxic materials threaten fish, migratory birds, and other wildlife. In order to maintain navigation, extensive annual dredging is required at the junction of the Rouge and Detroit Rivers and at the mouths of the Detroit and Raisin Rivers to remove deposits of suspended solids in large part originating in municipal and industrial waste discharges.

The Huron River carries significant quantities of coliform organisms, nitrates, and phosphates. It discharges into a large marsh at Pointe Mouillee with no clear dispersion into Lake Erie. The marsh is subject to backwater from the Detroit River. The backwater and the long retention of pollutants in the marsh tend to mask the effect of the Huron River on Lake Erie.

The lower Raisin River is frequently devoid of dissolved oxygen, resulting in a continuous state of putrefaction during the summer months. All uses of the lower Raisin River except waste disposal and navigation have been eliminated by pollution and deposits of settleable solids. Navigation is also hampered, and extensive annual dredging is required to remove deposited wastes to keep the channels open for routine ship movement. Bacterial counts in the lower River make any recreational use of the water hazardous. The detrimental effect of the Raisin River upon Lake Erie contributes to the enrichment of the waters of the western basin and the high coliform levels at bathing beaches nearby, including Sterling State Park.

The Michigan waters of Lake Erie have two major zones of pollution--one in the vicinity of the mouth of the Detroit River, and one near the mouth of the Raisin River. Bacteriological densities in the Lake from the mouth of the Detroit River to a point 2 or 3 miles south make the water unfit for recreational use; following heavy rainfall in the Detroit area, this zone is extended southward to Stony Point. Concentration of chlorides, metals toxic to fish life in minute concentrations, and suspended solids in the Lake portend future problems with various water uses.

Pollution stimulated algal growths have forced Monroe to move its water intake point to avoid unpleasant tastes and odors in the water, and algal blooms near the new intake again threaten to degrade Monroe's drinking water. Discharges of nutrients and organic wastes into the Michigan part of Lake Erie have speeded the enrichment of that portion of the Lake.

Water at Sterling State Park is erratically polluted, and this area occasionally has coliform counts exceeding 100,000 organisms per 100 ml. The Raisin River was found to be the chief source of this pollution; when Lake currents are northerly (40 to 45% of the time), polluted Raisin River water is carried directly to the beaches. When currents are southerly, drainage from malfunctioning septic tanks and wastes from Sandy Creek and Stony Creek north of the Park affect the beach water.

Adverse effects of stormwater overflow on water quality were found in the Detroit River and Michigan waters of Lake Erie. During and after heavy rainfalls, sewage plants bypass untreated wastes directly to the rivers, and this can be expected to occur 33 to 45 days a year. The overflows average 8.2 hours and have lasted as long as 5 days. Bacteria in storm overflows often approached the densities found in raw sewage, with counts as high as 100 million per 100 ml. Storm-caused overflows alone are responsible for the discharge of 5 billion gallons of raw sewage to the Detroit River yearly.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1965 O - 782-554